Resource management strategies

A key objective of the California Water Plan is to present a diverse set of resource management strategies to meet the water related resource management needs of each region and the state as a whole. Chapter 4 describes the importance of regional planning and presents general considerations for preparing sustainable integrated resource plans suitable for each region's unique character. This chapter describes over two dozen resource management strategies (listed alphabetically in the adjacent box) that can be integrated in various ways to fit the distinctive objectives and values of different regions and to achieve multiple resource benefits.

As California's water use has grown, many local agencies and governments have needed to diversify and use many different strategies to manage their water. This diversification has become even more essential with the growing understanding of the concurrent water demands of farms, cities and the environment. The strategies described in this chapter are the building blocks for future regional integrated resource plans that local agencies and governments should consider in developing balanced portfolios for their future human and environmental water demands.

Because the future is uncertain and stakeholders have a range of perspectives on how strategies could be integrated, DWR has considered several plausible yet different future conditions or scenarios that can be used by planners to test the performance of alternative strategy mixes, as described in Chapter 3.

The strategies

- *Agricultural Water Use Efficiency*
- *Aquifer Remediation*
- *Conjunctive Management*
- *Conveyance*
- *Desalination*
- *Drinking Water Treatment and Distribution*
- *Economic Incentives Policy*
- *Ecosystem Restoration*
- *Floodplain Management*
- *Matching Water Quality to Use*
- *Pollution Prevention*
- *Precipitation Enhancement*
- *Recharge Area Protection*
- *Recycled Municipal Water*
- *Surface Storage - CALFED/State*
- *Surface Storage - Regional/Local*
- *System Reoperation*
- *Urban Land Use Management*
- *Urban Runoff Management*
- *Urban Water Use Efficiency*
- *Water Transfers*
- *Water-Dependent Recreation*
- *Watershed Management*
- *Working Lands Management*
- *Other Research & Development*

California's resource management tool kit

As used in this report, a resource management strategy is an item of value (project, program or policy) that helps California's local agencies and governments manage their water and related resources. Urban water use efficiency to reduce urban water use is a strategy. A pricing policy or incentive for customers to reduce water use is also a strategy. New water storage to improve water supply, reliability or quality is a strategy.

Some may like to think of these strategies as individual tools in a tool kit. Just as the mix of tools in a tool kit will vary depending on the job to be performed, the combination of strategies will vary from region to region depending on the individual situations surrounding their water supply and use, climate, projected growth, and environmental and social conditions. Some strategies may not have much value in some regions. For example, due to geologic conditions, the opportunity for groundwater use in

Finding the best mix

Resource managers need to examine all of these strategies to identify the best mix for their region. The more a region can diversify its portfolio, the more robust and resilient it will be in facing future unknowns.

the Mountain Counties is not nearly as significant as in the Sacramento Valley.

Implementation of a set of strategies can reduce demand for water, make more water available, make the system operate more efficiently, and provide for other benefits such as improved water quality, flood management and ecosystem restoration.

Included in each of the strategy descriptions is an estimate of how much water supply, demand reduction, ecosystem restoration, or other benefits could be achieved on a statewide basis by 2030 along with its estimated cost. Since the potential application of these strategies can vary widely among the various regions, the strategy descriptions are from a broader, statewide perspective. More detailed information on the strategies is also presented in the Reference Guide (Volume 3) and the Technical Guide (Volume 4).

It is also important to recognize that there are issues and challenges associated with implementing each strategy. For instance, with water transfers there are concerns about third party impacts. With ocean water desalination there are issues with water intakes and brine disposal. For new off stream surface water storage there are questions about impacts of diversions on the rivers that would provide the water. With agricultural water use efficiency, there are potential impacts on downstream environmental resources dependent on tail water runoff.

In addition to identifying implementation issues, each strategy narrative contains recommendations on how the strategy could be implemented over the next 25-30 years to minimize its impacts, as well as how to promote additional implementation.

While the resource management strategies are presented individually (and alphabetically) to simplify the presentation, the potential for synergistic effects and trade offs should also be examined. Most strategies are interrelated and may not be additive. For instance, water from a recycling project could contribute to ecosystem restoration and groundwater recharge; while upstream water use efficiency may reduce the opportunity for downstream recycling and reuse.

In addition, the strategy narratives and their related recommendations are designed to recognize the many interactions between water and other resources. However, DWR does not have authority over some of these resources, and other state and local agencies and governments will continue to set policy over the resources within their jurisdictions. As appropriate, these policies and programs are articulated in the various resource management strategy narratives.

The strategies are based on the best available information, but supporting data for each strategy are currently not available to the same accuracy. In some cases, these are fairly rough estimates with broad ranges. Comprehensive evaluation criteria allowed the subject matter experts to evaluate the broad range of information for each strategy. DWR has not conducted detailed studies to verify this information on a statewide basis because the performance of individual strategies will depend on how they are combined and used in each region.

Subsequent to the December 2003 release of the public review draft Water Plan Update, DWR will initiate additional analyses under Phases 2 and 3 of the Water Plan update process (described in Chapter 1) to provide policy makers and resource managers more quantitative information on the performance of various strategies on a regional basis, interactions between strategies, and potential groupings or packages of strategies.

Each of the two dozen strategy narratives below is organized as follows:

- Definition and background
- Current level of implementation
- Potential benefits from additional implementation by 2030
- Potential costs of additional implementation
- Major issues facing implementation

Recommendations to help promote additional implementation

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Agricultural water use efficiency

Agricultural water use efficiency efforts involve improvements in technology or management of agricultural water use that result in benefits to water supply, water quality, and/or the environment. In 2000, California irrigated an estimated 9.6 million acres of cropland with approximately 34 million acre-feet of water (checking). In 2000, CALFED estimated the net water savings associated with proven improved agricultural water use efficiency measures to be 206,000 to 565,000 acre-feet per year including on-farm and district level actions at a cost of $110 to $1,000 per acre foot. A possible additional net water savings from regulated deficit irrigation (see sidebar at end of this section) is estimated to be 1 to 1.5 million acre-feet per year with a cost of $xx to yy.

Trends in Irrigated Acreage (in million acres)

Irrigation method	1990		2000		% change	% change
	Acreage	%	Acreage	%	(acreage)	(method)
Gravity (furrow, flood)	6.5	67.5	4.9	51.3	- 16.2	-24%
Sprinkler	2.3	23.8	2.8	28.8	5.0	21%
Drip/micro	0.8	8.7	1.9	19.9	11.2	129%
TOTAL	9.6	100	9.6	100		

source: DWR

Table xx. Trends in irrigated acreage. This table can be found at the end of this chapter. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size table.

Current status

California growers have made great strides in increasing the efficiency of their water use. One indicator of this improvement is that in 1980, California agriculture produced 1.53 tons of crops per foot of water applied. By the year 2000, growers produced 2.34 tons of crops per foot of water applied, approximately a 50 percent increase in production (DWR, confirming).

Improvements in the efficiency of agricultural water use result primarily from efforts in three related areas:

- improving on-farm irrigation systems and district water delivery systems: hardware upgrades
- managing on-farm irrigation systems and district water delivery systems more efficiently: water management, and
- reducing water consumption: reducing evapotranspiration

HARDWARE UPGRADES

The majority of orchards and vineyards in the state are under pressurized irrigation systems with almost all trees and vines established during last five to ten years receiving drip irrigation. Between 1990 and 2000, acreage with drip irrigation in California grew from 0.8 to 1.9 million acres (see table).

Advanced on-farm technologies in use include GIS, GPS and satellite crop and soil moisture sensing. The satellite-based technologies allow growers to improve the precision of their water application.

The shift to pressurized irrigation systems often requires modernization of the district water delivery systems. Increasingly, irrigation districts are upgrading and automating their systems to enable precise, flexible, and reliable deliveries to their customers. They are reducing system losses by lining canals or converting to pressurized pipe systems, developing spill recovery and tail water return systems; improving the efficiency of pumps; and implementing conjunctive water use programs. Even with existing efforts presently underway, there is still a great opportunity for on-farm irrigation and district water delivery system improvements.

WATER MANAGEMENT

Both on-farm and district systems must be managed efficiently to take advantage of hardware improvements. Districts are using tools including automated gates operated using SCADA systems along with computer-based monitoring equipment, including workstations, map boards, file and database servers, and centralized communications equipment. Personal computers connected to real-time communication networks and a local area network allow a free flow of information from the field to any workstation computer. These features enable district staff to monitor flow, exert supervisory control over each field site, and log data on a continuous, electronic basis.

With such systems, district staff spends less time monitoring and manually controlling individual sites, allowing them to plan and operate the system in a strategic and integrated manner. This facilitates a systemwide view along with improved reliability of the communications system.

Many growers employ evapotranspiration and soil moisture data for irrigation scheduling and use sophisticated automated and computerized irrigation systems for irrigation, fertilizer, and pest management. They use real time satellite weather information and forecasting capability systems for irrigation scheduling. Users generate over 70,000 inquiries per year to the California Irrigation Management Information System (CIMIS), the Department of Water Resources' weather station program that provides evapotranspiration data. Universities, districts, and consultants also make this information available indirectly via newspapers, websites, and other media to a much wider audience.

In addition, those who irrigate by gravity employ laser leveling and engineered furrow, basin and border designs to ensure that water application meets crop and soil water requirements. Growers use other methods and technologies to schedule their irrigation as well and some districts provide a Mobile Lab service to conduct in-field evaluation of irrigation systems coupled with irrigation management recommendations.

REDUCING EVAPOTRANSPIRATION

Evapotranspiration is the amount of water that evaporates from the soil or transpires from the plant. A grower can reduce evapotranspiration, that is, water demand, by:

reducing unproductive evaporation (water that evaporates from the soil surface);

altering plant water requirements through genetics (plant breeding);

shifting crops (to plants that need less water); or

reducing evapotranspiration (regulated deficit irrigation- see sidebar.)

Today, the most promising avenue to reduce evapotranspiration on a large scale appears to be through the reduction of transpiration.

Benefits

Overall, on-farm improvements in water use efficiency can benefit farmers by increasing net profit, reducing water applied, reducing groundwater overdraft, increasing yield, improving crop quality, lowering the cost of inputs, and potentially profiting from the sale of the conserved water.

District water system improvements can benefit districts by increasing their ability to meet their customers' demand and reducing water losses. Shifting electric load from on-peak to off-peak could be another benefit related to agricultural water use efficiency.

Environmental benefits may include water quality improvements as well as reduced drainage, surface runoff, and associated TMDLs (Total Maximum Daily Loads), increased stream flow and improvements in temperature and timing. The multiple benefits associated with agricultural water use efficiency in key agricultural regions have been evaluated by CALFED and described regionally from a watershed perspective as 'quantifiable objectives'. Occasionally, improvements in water use efficiency on the field can cause negative environmental effects, such as reduced runoff to water bodies downstream.

In addition to meeting CALFED goals, California must also reduce the use of Colorado River water from 5.2 to 4.4 million acre-feet. California for many years has been using more than its annual allocation.

In 2000, CALFED estimated the net water savings associated with improved agricultural water use efficiency to be 206,000 to 565,000 acre-feet per year including on-farm and district level actions. The CALFED estimates include proven improvements in irrigation hardware and scheduling, but not reductions in evapotranspiration. Possible estimated net water savings associated with reductions in evapotranspiration (regulated deficit irrigation) would be from xx to yy million acre-feet.

Potential costs

The CALFED Record of Decision estimated water savings at two levels of expenditures. The first level results when growers and water districts implement efficient water management practices as a part of their standard operation. This level estimates net water savings of 118,000 to 322,000 AF per year at a cost of $35 to $ 95 per acre-foot. The second level results from the investment of funds by the state and federal agencies with net savings ranging from 88,000 to 243,000 AF per year at a cost of $80 to $900 per acre-foot. CALFED, therefore, identified a total of 206,000 to 565,000 AF of net water savings per year at a cost of $110 to $1000 per af/year. The cost assumes on-farm efficiency of 85%.

Major issues

The major issues related to improving agricultural water use efficiency in California are related to:

- funding;
- implementation;
- measurement, planning and evaluation;
- education and motivation;
- innovation; and
- dry year considerations.

FUNDING

Additional funding is needed for agricultural water use efficiency projects. Funds dedicated to water use efficiency have fallen well below commitments made in 2000 through the CALFED Record of Decision that called for an investment of $1.5 billion to $2 billion from 2000-2007. State and federal agencies committed to funding 50 percent (25 percent each) with local agencies funding the remaining 50 percent of water use efficiency activities. State and federal expenditures are listed below. To date, no evaluation has been made of local investments in water use efficiency.

Through the Agricultural Water Management Council's Memorandum of Understanding (MOU), local agencies have committed to funding locally cost effective Efficient Water Management Practices (EWMPs). State and federal programs, on an irregular basis, provide a source of funding for the EWMPs beyond the MOU level, for actions other than standard EWMPs, and for those EWMPs that may not be locally cost effective.

ROD Expenditure Projections, including State, federal and local shares and Actual State and Federal Expenditures to Date (in $ millions)

Year	2001	2002	2003	2004	2005	2006	2007	Total
ROD Proj.	31	62	299	641	641	641	641	2,956
Actual Expend.	?	?	?	?	?	?	?	?

Table xx. ROD expenditure projections. This table can be found at the end of this chapter. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size table.

While the initiative process has provided state funding for water use efficiency projects through Propositions 13 and 50, retaining a sufficient state and federal expertise to administer the programs and provide financial and technical assistance in this field is not easy with across the board budget and staff cutbacks. Many irrigation districts also face increasing challenges to implement water use efficiency actions and to maintain a permanent expertise or institutional continuity with limited staff and budgets.

Investments in research and demonstration are critical. Substantial financial support for research, development and the demonstration of efficient water management practices in agriculture has come and continues to come from the agricultural industry. Support also comes from the early adopters of new technology who often risk their crops, soils and dollars when cooperating to develop and demonstrate technology innovations.

Grant programs may miss the opportunity to fund worthwhile projects in small and disadvantaged communities. It is often difficult for them to compete for limited grant funds, although their needs are often great. The impact on farm workers is often neglected when considering different approaches to water use efficiency.

In some areas of the state, funding for water conservation comes from the ability to transfer water. Such water sales may play a significant role in financing future water use efficiency efforts.

IMPLEMENTATION

Much has been accomplished, but still more needs to be done to increase agricultural water use efficiency and to optimize agricultural profits per unit of water without compromising water quality or the environment.

The Agricultural Water Suppliers Efficient Water Management Practices Act of 1990 (AB 3616) and the Central Valley Project Improvement Act (CVPIA) established a framework for agricultural water use efficiency. Developed under AB 3616, over 50 California water suppliers have entered into a voluntary and cooperative Memorandum of Understanding Regarding Efficient Water Management Practices (EWMPs) by Agricultural Water Suppliers. The retail districts, comprising over 3.65 million acres of irrigated agricultural land statewide, are committed to developing water management plans and implementing cost-effective EWMPs. The California Agricultural Water Management Council oversees the progress of water management planning and the implementation of EWMPs.

A number of water suppliers have not joined the MOU and many who have joined have not submitted plans or fully implemented efficient water management practices. Small districts often do not have the technical and financial abilities to develop plans or implement efficient water management practices. Opportunities exist beyond the implementation of EWMPs that could result in major improvements in water use efficiency as well as new methods and technologies that can be expected to significantly increase conservation potential.

The CALFED Record of Decision of 2000 (ROD) further institutionalized agricultural water use efficiency. State and federal agencies are committed through the ROD to provide financial and technical assistance to local agencies for the implementation of water use efficiency measures.

Hardware Upgrades

Optimum operation of irrigation and distribution systems can significantly improve water use efficiency. An issue to growers is often the inability to apply the exact amount of irrigation water when they need it. Water system improvements such as integrated supervisory control and data acquisition systems (SCADA), canal automation, regulating reservoirs, and other hardware and operational upgrades, could provide flexibility to deliver the water when and where it is needed in the appropriate quantities.

Growers invest significantly in on-farm irrigation system improvements. In terms of future investments, the Cal Poly Irrigation Training and Research Center estimates that 3.8 million acres could be converted to precision irrigation such as drip or micro-spray irrigation. While this may not reduce crop demand, it could improve the distribution uniformity of water applied, reduce non-beneficial evaporation losses, and thus allow the grower to apply less water to the field. Research has shown water application reduction at two to three percent with yields increasing from 19 to 35 percent, an increase in productivity of 30 percent with the same amount of water (verifying with Cal Poly.)

Water management

While designing, installing and maintaining efficient irrigation and water distribution systems are essential, the management of water through the district distribution system and irrigation scheduling on farm are also extremely important. Some good tools and information are available for district system management and irrigation scheduling, but more efforts to refine those tools and better reach, educate, and motivate districts and growers could increase water savings.

Reducing evapotranspiration

More efforts need to be dedicated to researching and promoting ways growers can reduce evapotranspiration.

MEASUREMENT, PLANNING AND EVALUATION

The measurement of water and associated information provided to the water user is essential to efficient water management. Without a measurement of water applied, a grower cannot manage water efficiently.

Documenting water savings related to the various programs rests on the ability to track water use. Water use is not measured in some areas of the state.

There is a lack of sufficient statewide comprehensive data on the acreage under various types of irrigation systems, methods of irrigation, amount of applied water, crop water use, cultural requirements, irrigation efficiency, the accurate measurement of water use and net water savings, and the cost of irrigation improvements. These are obstacles for assessing current irrigation efficiencies and planning for further improvement. The collection and management and dissemination of such data to growers, districts, and state planners are necessary for promoting water use efficiency.

Information on the effect of reducing non-productive evaporation losses and reducing crop evapotranspiration is lacking. Similarly, not enough is known about the potential savings associated with controlled crop dry-down of alfalfa, where growers forego the late summer cuttings of alfalfa in order to use that water on another field or to voluntarily transfer water, or alternative land use in a voluntary and compensated program during dry years.

Use of pressurized irrigation systems has recently increased and has improved water use efficiency. These systems require energy, facilities, and materials for proper operation. The long-term costs and benefits of these systems merit study.

EDUCATION AND MOTIVATION

Likewise, there is a need for information related to why California growers adopted water use efficiency practices and how those practices could be encouraged and sustained. Furthermore, we are not sure what types of incentives districts respond best to, while we have seen evidence of a strong response to financial incentives whenever offered in a simple, understandable format and process. Which technological changes should be pursued for short term situations (during water shortages) compared to long term, and which behavioral changes are most effective short and long term?

INNOVATION

New agricultural water conservation technologies and techniques will be needed to meet the demand for water over time. For example, the water-saving weather-based controllers (ET controllers) that are becoming increasingly popular in the urban sector may have an important role to play in the agricultural sector as well. By establishing an atmosphere where growers and districts can pursue new methods while keeping production risks to a minimum, these practices can be adopted.

DRY-YEAR CONSIDERATIONS

Measures can and need to be taken now to prepare for dry years. Agriculture is often called upon during dry years to refrain from farming a portion of land with compensation for the water not used. Traditional approaches to meet water needs during dry years need to be reviewed and other approaches need to be explored, such as an alfalfa summer dry down program.

Recommendations

The following actions reflect some of the possible solutions to the issues raised in the previous section. A wide range of strategies will need to be employed to accomplish the actions including financial incentives; revisions in state and local codes and standards; and legislative initiatives. Most of these activities will be cooperative efforts, involving state, federal, and local agencies, growers, and other stakeholders.

Fund agricultural water use efficiency projects

- Secure $XX of funding to support incentive programs, both implementation and evaluation, and associated expertise at the local level as well as at the state and federal levels.

- Identify and establish priorities for future grant programs and other incentives.
- Fund technical and planning assistance to improve water use efficiency including local efforts to implement EWMPs and meet CALFED WUE goals, as well as the implementation of Quantifiable Objectives.
- Fund research, development, and demonstration projects that could promote improved agricultural water use efficiency.
- Fund technical assistance programs that encourage growers' use of advances in irrigation systems and management technologies.
- Work with tribes and community-based organizations to get the word out and assist in the development of proposals.
- Provide ample opportunities for small districts and economically disadvantaged communities to benefit from technical assistance, planning activities, and incentive programs.
- Honor environmental justice policies established by funding agencies and others.

Expand implementation efforts

General

- Encourage additional signatories to the Agricultural Water Management Council's Memorandum of Understanding and full implementation of Efficient Water Management Practices by present signatories. Encourage the addition of new EWMPs as benefits are identified.
- Employ urban recycled water for agriculture whenever feasible.

Hardware upgrades

- Eliminate or reduce the losses (spills, seepage and non-beneficial evaporation) from district water distribution systems.
- Upgrade on-farm irrigation systems to more efficient levels.

Water management

- Modernize water distribution and management systems to improve the flexibility of water deliveries including water system improvements such as integrated supervisory control and data acquisition systems (SCADA), canal automation, regulating reservoirs, and other hardware and operational upgrades.
- Expand CIMIS, mobile laboratory services, and other training and education programs to improve irrigation scheduling and efficiency.

Reducing evapotranspiration

- Fund large and long-term RDI demonstration and research plots as well as other promising programs to reduce evapotranspiration and document potential savings.
- Develop necessary protocols and guidelines for growers and districts to promote implementation.
- Fund research on producing increased yield and higher quality of crops with the same water use through subsurface drip and other on-farm technologies.

Measure, plan and evaluate

- Measure water to customer and bill by volume of use with rate structures that encourage water use efficiency.
- In cooperation with the agricultural community, support scientific research, development, demonstration, monitoring and evaluation components of agricultural water use efficiency technologies and management practices.
- Collect, manage and disseminate statewide data on acreage under various irrigation methods, the amount of water applied, crop water use, and the benefits and costs of water use efficiency measures.
- Work with state and federal grant recipients and others to obtain more useful and consistent data from funded projects and other activities, including the documentation of sources and methods behind data presented.
- Encourage comprehensive planning and implementation of water conservation activities at the agency and regional level.
- Gather information through surveys and other instruments on how growers use water.
- Develop comprehensive methodology for quantifying irrecoverable losses and for analyzing benefits and costs of projects.
- Couple research and technology development with incentive-based implementation programs.
- Evaluate the environmental impacts of water use efficiency.

Educate and motivate

- Develop community based social marketing surveys and strategies for conservation activities to foster water use efficiency, with the participation of the agricultural and water industries and environmental interests.

- Identify and overcome barriers to improved water use efficiency, communicate the benefits, provide incentives, and gain commitment from all involved.

Innovate

- Explore and identify innovative technologies and techniques to improve water use efficiency and develop new EWMPs to correspond with new information.
- Fast track pilot projects, demonstrations, and model programs exploring state-of-the-art water saving technologies and procedures and publicize results widely.

Prepare for dry years and extraordinary shortages

- Have a comprehensive campaign ready to go for next drought.
- Conduct contingency planning for extraordinary short- and long-term shortages.
- Support further research in development of strategies for voluntary alternative land use in drainage impaired lands.
- Support further research in summer crop dry-down and explore incentives for farmers and districts to forego summer cut of alfalfa, and other similar programs.

Side bar:

Regulated deficit irrigation

Regulated Deficit Irrigation (RDI) is an irrigation management strategy that purposely stresses the trees or vines at specific developmental stages with the goal of reducing crop water use, improving crop quality, decreasing disease or pest infestation or reducing production costs without reducing yield or profits. RDI was first developed in Australia and New Zealand in the 1980's. Research began in California in the 1990's with initial results showing the potential for significant water savings (a reduction in evapotranspiration) while increasing or maintaining crop profitability and allowing optimum production.

The traditional irrigation management strategy has been to avoid crop water stress. RDI is used primarily on tree and vine crops where crop quality as well as yield is of primary concern. Stress imposed at specific growth stages can improve crop quality, even though it limits or reduces plant growth or development. Wine grapes are a clear example: mild stress imposed through the growing season decreases canopy growth, but pro-

Significant improvements

Kern County Water Agency reports significant improvements in irrigation efficiency. An analysis of data in 1986 compared to 1975 showed an 8 percent improvement (from 67 percent in 1975 to 75 percent in 1986). This improvement has reduced the total applied water use in the San Joaquin Valley portion of Kern County by about 250,000 acre-feet, enough water to irrigate about 70,000 acres. Since 1986 Kern County has added 61,500 acres of trees and vines. These now make up 37 percent of the total irrigated acreage. Nearly all of this

Crop	Bearing Acreage	Estimated Savings (inches)	Water Savings (acre-feet)
Almonds	530,000	8- 14	424,000- 618,000
Winegrapes	480,000	8- 12	320,000- 480,000
Citrus	244,000	6- 8	122,000- 163,000
Pistachios	78,000	10- 12	65,000- 78,000
Prunes	76,000	6- 12	38,000- 76,000
Peaches	70,000	4- 8	23,000- 47,000
Olives	36,000	6- 10	18,000- 30,000
Apples and Pears	49,000	4- 8	16,000- 33,000
Walnuts	196,000	Unknown	Unknown
Total	1,759,000		1,026,000- 1,525,000

Table xx. Range of estimated net water savings relative to current practices using regulated deficit irrigation (RDI). This table can be found at the end of this chapter. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size table.

duces grapes with higher sugar content, better color and smaller berries with a higher skin to fruit volume ratio.

RDI is a relatively new research area in California. Research has been conducted on wine grapes, prunes and pistachios for the past ten years. Less research has been done on almonds, citrus, peaches, olives, apples, pears and walnuts. RDI has begun to be widely accepted in wine grapes with wineries and other trade groups promoting the irrigation strategy. To some extent, this is true for pistachios as well. It has not been widely used yet with any other crops in California.

Regulated deficit irrigation in particular could result in several possible benefits. First, through increased productivity and efficiency, the economics of tree and vine production could become more profitable. Some crops disease and insect problems could be lessened, decreasing the application of pesticides.

If RDI is adopted by a significant percentage of growers in the state; RDI could result in substantial statewide water savings. Dr. David Goldhamer of the University of California Cooperative Extension has estimated potential water savings ranging from four to 14 inches per year. He then extrapolated the potential statewide savings by applying the crop savings to the approximate crop acreage. The estimated water savings for RDI range from one million to 1.5 million acre-feet per year, see table.

The cost of RDI is estimated to be $10 per acre-foot per year. (Dr. Goldhamer's basic assumptions for this estimate: 500 acres of trees x 6 inches of savings per year equals 250 acre-feet per year. One temporary help, minimum wage of $6.50/hour, $1000 per month for 2.5 months of the early irrigation season equals $2,500 to take pressure chamber readings, record data, provide to irrigator. $2,500/250 equals $10 per acre foot). Assuming that most tree and vine crops that will be using this strategy are irrigated by drip, other micro irrigation technologies, or other uniform, controllable systems, costs would be limited to irrigation management.

Long term and large-scale studies and demonstration projects need to be conducted before the practice can be promoted and encouraged for commercial production on a wide scale. Areas for further study include: the current extent of deficit irrigation for each crop to verify estimated water savings potential; the potential for increased disease and insects infestations that could limit production and shorten tree lifespan; the potential of RDI on trees to become alternate bearing; and the affect of RDI on crop quality and yield measured over a number of years and during different water years.

RDI may require more management and data collection to support this technique. Technical and economic aspects of RDI need further studies and the development of protocols and guidelines for full implementation by growers.

ROD Expenditure Projections, including State, federal and local shares and Actual State and Federal Expenditures to Date (in $ millions)

Year	2001	2002	2003	2004	2005	2006	2007	Total
ROD Proj.	31	62	299	641	641	641	641	2,956
Actual Expend.	?	?	?	?	?	?	?	?

Aquifer remediation

In Progress

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Conjunctive management

Conjunctive management is the coordinated operation of surface water storage and use, groundwater storage and use, and conveyance facilities. Although surface water and groundwater are sometimes considered to be separate resources, they are connected by the hydrologic cycle. Streams can receive dry weather base flow from groundwater storage, and streams provide wet weather recharge to groundwater storage. Water quality of both resources and the environment can also be influenced by their interaction. Conjunctive management allows these two resources to be managed in an efficient manner by taking advantage of the ability of surface storage to capture and temporarily store storm water and the ability of aquifers to serve as long term storage.

A key aspect of conjunctive management projects is groundwater recharge. Groundwater recharge is the movement of surface water from the land surface, through the top soil and subsurface, and into empty aquifer space. Recharge occurs naturally from precipitation falling on the land surface, from water stored in lakes, and from creeks and rivers carrying storm runoff. Recharge also occurs artificially from water placed into constructed recharge ponds (also called spreading basins), from water injected into the subsurface by wells, and from surface storage releases into creeks and rivers beyond what occurs from the natural hydrology (for example, by releases of imported water). Significant amounts of artificial recharge can also occur either intentionally or incidentally from applied irrigation water and from water placed into unlined or leaky conveyance facilities. Groundwater banking is the recharge (often of imported surface water, or local flood water) into empty groundwater storage space for later recovery and use or exchange with others.

Conjunctive management is implemented to meet resource management objectives. For example, to improve water supply reliability, to reduce groundwater overdraft and land subsidence, to protect water quality, and more recently to improve environmental conditions. There are three primary components to a conjunctive management project. The first is to recharge surface water when it is available to increase groundwater storage. In some areas this is accomplished by reducing groundwater use and substituting it with surface water, allowing natural recharge to increase groundwater storage (also called in-lieu recharge). The second component is to switch to groundwater use in dry years when surface water is scarce. The third component is to have an ongoing monitoring program to evaluate and allow water managers to respond to changes in groundwater, surface

Sources

- *SWRCB. "Water Transfer Issues in California: Final Report to the California State Water Resources Control Board by the Water Transfer Workgroup". June 2002.*
- *CALFED. Common Assumptions, Conjunctive Use Inventory. In progress.*
- *CALFED. "Conjunctive Use Site Assessment – Draft Report". December 23, 1999*
- *Association of Groundwater Agencies (AGWA). "Groundwater and Surface Water in Southern California." October 2000.*
- *Natural Heritage Institute. "Designing Successful Groundwater Banking Programs in the Central Valley". 2000.*
- *Natural Heritage Institute. "Estimating the Potential for In-Lieu Conjunctive Water Management in the Central Valley". February 2002.*
- *Natural Heritage Institute. "The Hydrogeological Suitability of Potential Groundwater Banking Sites in the Central Valley". September 2001.*
- *Natural Heritage Institute. "Feasibility Study of Maximal Program of Groundwater Banking." December 1998.*
- *U.S. Army Corps of Engineers. Conjunctive Use for Flood Protection. January 2002.*
- *Proposition 13 Groundwater Storage Applications to DWR for fiscal year 2001-2002.*
- *A 2000 report by the Association of Groundwater Agencies titled, "Groundwater and Surface Water in Southern California"*
- *A 1998 report by the Natural Heritage Institute titled, "Feasibility Study of a Maximal Program of Groundwater Banking"*
- *A 2002 report by the Natural Heritage Institute titled, "Estimating the Potential for In-Lieu Conjunctive Management in the Central Valley"*
- *A 2002 report by the U.S. Army Corps of Engineers report entitled, "Conjunctive Use for Flood Protection". Methodology for obtaining these estimates is presented in Volume 4.*

water, or environmental conditions that could violate management objectives or impact other water users. Together these components make up the conjunctive management project.

Current status

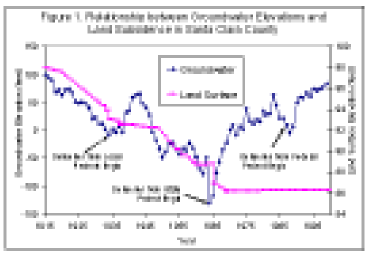


Figure X Relationship between groundwater elevations and land subsidence in Santa Clara County. Full graph can be found on page XX. In a digital version, this would be linked and opened by clicking.

Conjunctive management has been practiced in California to varying degrees since the Spanish mission era. The first known artificial recharge of groundwater in California occurred in Southern California during the late 1800's and is now used as a management tool in many areas. Since surface and groundwater management are closely linked, it is difficult to separate specific benefits of each. Two examples illustrate the types of conjunctive management underway on a regional and local scale. In Southern California, including Kern County, conjunctive management has increased average year water deliveries by over 2 million acre-feet (AGWA, 2000). Over a period of years, artificial recharge in these areas has increased the water currently in groundwater storage by approximately 7 million acre-feet.

Santa Clara Valley Water District releases local supplies and imported water into more than 20 local creeks for artificial instream recharge and into more than 70 recharge ponds to recharge a total of about 157 thousand acre-feet annually. Conjunctive management has virtually stopped land subsidence caused by heavy groundwater use and has allowed groundwater levels to recover to those of the early 1900s (see accompanying figure).

While comprehensive statewide data on conjunctive management is not available, DWR's Conjunctive Water Management Program provides an indication of the types and magnitude of projects that water agencies are currently pursuing. The program has awarded over $130 Million in grants and loans for project funding and study throughout California in fiscal years 2001 and 2002 (see Figure 2).

Potential benefits

Conservative estimates from additional conjunctive management indicate the potential to increase average annual water deliveries throughout the state by 500 thousand acre-feet with about 9 million acre-feet of "new" groundwater storage. New storage includes both reoperation of existing groundwater storage and recharging water into currently empty groundwater storage space. More aggressive estimates from screening level studies indicate the potential to increase average annual water deliveries by 2 million acre-feet with about 20 million acre-feet of new storage.

The potential benefits from additional conjunctive management are highly dependent on adequate water quality and the ability to capture, convey, and recharge surface water. The above estimates are based on increases in local water deliveries from individual projects only and do not necessarily reflect a statewide increase in supply reliability. An increase in statewide supply reliability only occurs when the individual projects utilize water that would otherwise not be used by other water users or the environment. The more aggressive estimates are based on assumptions that require major reoperation of existing surface water reservoirs and groundwater storage to achieve the benefits and do not fully consider the conveyance capacity constraints for exports from the Delta and other conveyance facilities.

In addition to water supply benefits, conjunctive management can provide environmental benefits when recharge basins are designed to be compatible with wildlife habitat, such as utilizing natural floodplains and wetlands as recharge areas. Re-operation of surface water storage and use conjunctively with groundwater storage and use can avoid impacts to aquatic species by allowing better management of instream flow and water quality conditions.

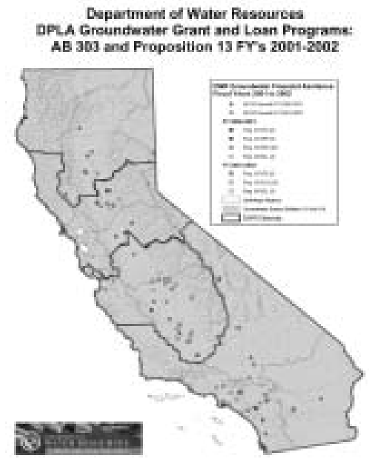


Figure X DPLA groundwater grant and loan programs: AB 303 and Proposition 13 FYs 2001-2002. Full graph can be found on page XX. In a digital version, this would be linked and opened by clicking.

Potential costs

Grant applications from DWR's fiscal year 2001-2002 Conjunctive Water Management Program show project costs ranging from $10 to $600 per acre-foot of increase in average annual delivery. The wide range of costs is due to many factors including project complexity, regional differences in construction costs, availability and quality of recharge supply, intended use of water, and treatment requirements. In general, urban uses can support higher project costs than agricultural uses. The average project cost of all applications received by DWR is $110 per acre-foot of increase in average annual delivery. This average project cost is a weighted average, which weights each project by the relative increase in water deliveries. While these cost estimates are specific to projects evaluated by DWR, they provide a good indication of implementation costs statewide.

Major issues

Lack of Data – Data is needed to evaluate conditions and trends laterally over an area, vertically at different depths, and over time. There is rarely a complete regional network to monitor groundwater levels, water quality, land subsidence, or the interaction of groundwater with surface water and the environment. Also, there is often a reluctance of individuals who own groundwater monitoring or supply wells to provide information or allow access to collect additional information. The result is that decisions must be made with only approximate knowledge of the "true" system. This uncertainty can make any change in operation of groundwater storage unpredictable and controversial.

Infrastructure Needs – The physical capacity of existing storage and conveyance facilities are often not large enough to capture surface water when it is available in wet years. For example, when there is surface water available for export from the Delta, export facilities are already pumping at full capacity and additional water cannot be moved to groundwater banks south of the Delta. Expanding existing or developing new storage or conveyance infrastructure can increase the flexibility and ability to conduct conjunctive management projects. It is also possible to reoperate the existing system to increase the benefits of conjunctive management.

Interconnection between Surface Water and Groundwater – In California, water management practices and the water rights system treat surface water and groundwater as two unconnected resources. In reality, there is often a high degree of hydrologic connection between the two. Under predevelopment conditions many streams received dry weather base flow from groundwater storage, and streams provided wet weather recharge to groundwater storage. Water quality and the environment can also be influenced by the interaction between surface water and groundwater. Failure to understand these connections can lead to unintended impacts. For example, pumping more groundwater than is recharged over the long term has reduced or eliminated dry year base flow in some streams, which can reduce the water available to other water users and the environment.

Water Quality – The flexibility of conjunctive management projects is influenced by the quality of both the recharge water and the receiving groundwater as well as the intended end use for the water. Groundwater quality can be degraded by low quality recharge water, naturally occurring or human introduced chemical constituents, or chemical reactions caused by mixing water of differing qualities. Protection of human health, the environment, and groundwater quality is a concern for programs that recharge urban runoff or reclaimed/ recycled water. The intended end use of the water can also influence the implementation of conjunctive management projects. For example, agriculture can generally use water of lower quality than needed for urban use, but agriculture can be sensitive to certain constituents like boron. New and changing water quality standards and emerging contaminants add uncertainty to implementing conjunctive management projects.

Environmental Concerns – Environmental concerns related to conjunctive management projects include potential impacts on habitat, water quality, and wildlife caused by shifting or increasing patterns of groundwater and surface water use. For example, flood waters are typically considered "available" for recharge. However, flood flows serve an important function in the ecosystem, and removing or reducing floods can negatively impact the ecosystem. A key challenge is to balance the instream flow and other environmental needs with the water supply aspects of conjunctive management projects. There may also be impacts from construction and operation of groundwater recharge basins and new conveyance facilities.

Funding – There is generally limited financing to develop the infrastructure and monitoring capability to fully implement and monitor conjunctive management projects. This includes funding to develop and implement groundwater management plans, to study and construct conjunctive management projects, and to track, both statewide and regionally, changes in groundwater levels, groundwater flows, groundwater quality (including the location/spreading of contaminant plumes), land subsidence, changes in surface water flow, surface water quality, and the interaction and interrelated nature of surface water and groundwater.

Disjointed Authority over Water Resources – In California, authority is compartmentalized among local, state and federal agencies for managing different aspects of groundwater and surface water resources. Several examples highlight this issue: 1) SWRCB regulates surface water rights dating from 1914, but not rights dating before 1914; 2) SWRCB also regulates groundwater quality, but not the rights to use groundwater; 3) Ordinances adopted by counties to protect groundwater resources only apply to the portion of the groundwater basin they overlie and may conflict with water districts that have their own groundwater management plan. 4) Except in adjudicated basins, individuals have few restrictions on how much groundwater they can use, provided the water is put to beneficial use on the overlying property. This disjointed authority makes it difficult to manage water for multiple benefits and provide for sustainable use including the ability to identify and protect or mitigate potential impacts to third parties, ensure protection of legal rights of water users, establish rights to use vacant aquifer space and banked water, protect the environment, recognize and protect groundwater recharge and discharge areas, and protect public trust resources.

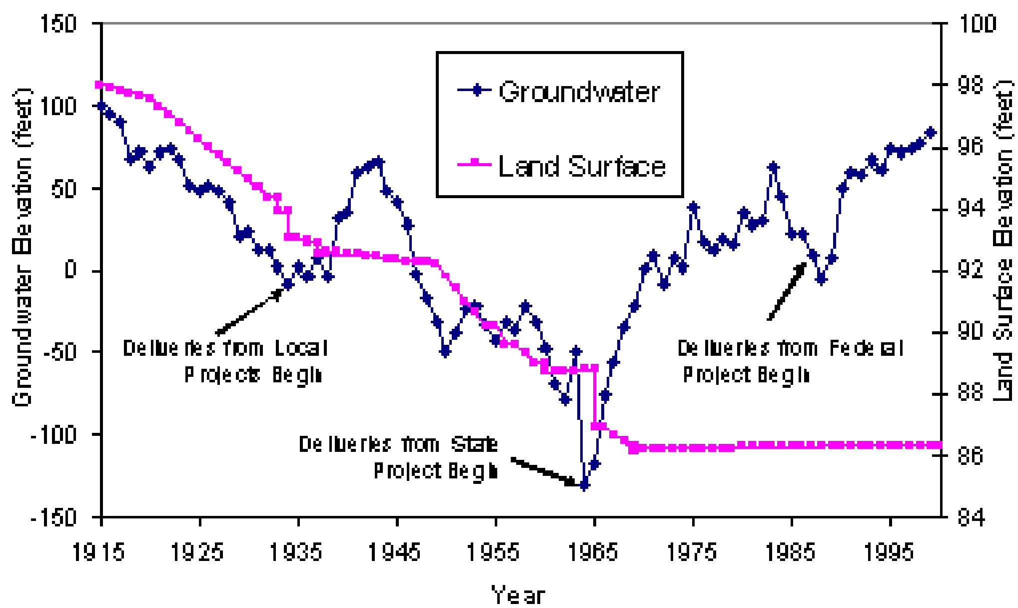
Recommendations

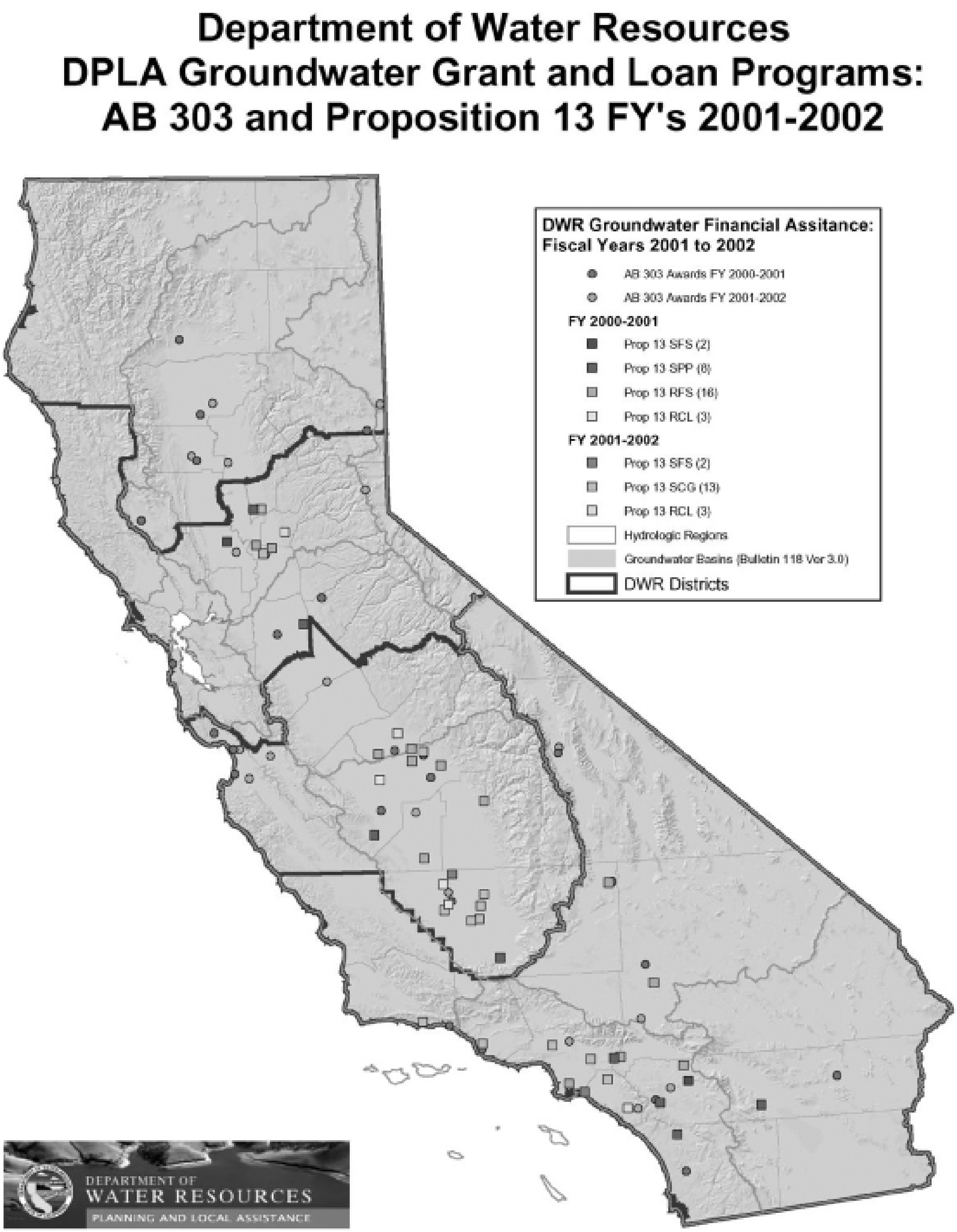
- Continue funding for local groundwater monitoring and management activities, feasibility studies, and construction of facilities that enhance the coordinated use of groundwater and surface water. Additional monitoring and analysis is needed to track, both statewide and regionally, changes in groundwater levels, groundwater flows, groundwater quality (including the location/spreading of contaminant plumes), land subsidence, changes in surface water flow, surface water quality, and the interaction and interrelated nature of surface water and groundwater. There is a need to develop comprehensive data on existing, proposed, and potential conjunctive management projects throughout the state and identify and evaluate regional and statewide implementation constraints including availability of water to recharge, ability to convey water from source to destination, water quality issues, environmental issues, and costs and benefits.
- Give priority for funding and technical assistance to conjunctive management projects that are conducted in accordance with a groundwater management plan, improve supply reliability, and have other benefits including the sustainable use of groundwater, maintaining or improving water quality, and enhancing the environment. In addition, allow funding for projects that make use of wet season / dry season supply variability, not just wet year / dry year variability.
- Encourage the development of regional groundwater management plans. A 'regional plan' has no specific definition. However, local water management agencies should coordinate with other agencies that are involved in activities that might affect long term sustainability of water supply and water quality within the basin or adjacent to the basin. Such regional coordination will take different forms in each area because of dissimilar political, legal, institutional, technical, and economic constraints and opportunities. Regional groundwater management plans should be developed with assistance from an advisory committee of stakeholders to help

guide the development, educational outreach, and implementation of the plans.

- Assess groundwater management throughout the state to provide an understanding of how local agencies are implementing actions to use and protect groundwater, an understanding of which actions are working at the local level and which are not working, and how state programs can be improved to help agencies prepare effective groundwater management plans.
- Improve coordination and cooperation among local, state, and federal agencies with differing responsibilities for groundwater and surface water management and monitoring to facilitate conjunctive management, to ensure efficient use of resources, to provide timely regulatory approvals, to prevent conflicting rules or guidelines, and to promote easy access to information by the public.
- Encourage local groundwater management authorities to manage the use of vacant aquifer space for artificial recharge.
- Encourage the development of multi-benefit projects that generate source water for groundwater storage by capturing water that would otherwise not be used by other water users or the environment. For example through reservoir reoperation, water recycling and reuse, and water conservation.
- Work with wildlife agencies to streamline the environmental permitting process for the development of conjunctive management facilities, like recharge basins, when they are designed with pre-defined benefits or mitigation to wildlife and wildlife habitat.

Figure 1. Relationship between Groundwater Elevations and Land Subsidence in Santa Clara County




Department of Water Resources
DPLA Groundwater Grant and Loan Programs:
AB 303 and Proposition 13 FY's 2001-2002
DWR Groundwater Financial Assitance:
Fiscal Years 2001 to 2002
AB 303 Awards FY 2000-2001
AB 303 Awards FY 2001-2002
FY 2000-2001
Prop 13 SFS (2)
Prop 13 SPP (8)
Prop 13 RFS (16)
Prop 13 RCL (3)
FY 2001-2002
Prop 13 SFS (2)
Prop 13 SCG (13)
Prop 13 RCL (3)
Hydrologic Regions
Groundwater Basins (Bulletin 118 Ver 3.0)
DWR Districts
DEPARTMENT OF
WATER RESOURCES
PLANNING AND LOCAL ASSISTANCE

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Conveyance

Conveyance provides for the movement of water. Conveyance infrastructure includes natural watercourses as well as constructed facilities like canals, pipelines and related structures (pumping plants, diversions, distribution systems, fish screens, etc.) Groundwater aquifers are also used to convey water. The primary objectives of natural and managed water conveyance activities include flood management, environmental consumptive and non-consumptive uses as well as urban or agricultural water deliveries. This narrative discusses two distinct perspectives of water conveyance: (1) the movement of water *between regions* of the state such as through the Sacramento-San Joaquin Delta, Colorado River imports, the Hetch-Hetchy system or the LA Aqueduct; and (2) the equally important role that conveyance plays in water reliability at the local level or *within regions*.

Current status

Every water project in California uses some type of conveyance to move water from the source to where it is needed, and such conveyance often includes California's natural watercourses. In California, an extensive system of conveyance projects has been developed that can move water with the use of its natural and constructed waterways over 600 miles from source region to region of use. At the local level, water is distributed from a locally developed source, such as desalination, to the end user. Since the state's ecosystem depends on water flow and quality in creeks, streams and rivers, an overall objective is to balance the operation and maintenance of these conveyance facilities to meet the needs of all sectors – including environmental.

Conveyance between regions

The importance of conveyance between regions in California is evident when examining the geographical areas of highest precipitation that are generally in northern California, and areas of highest water use (primarily in the Central Valley, Bay Area, and South Coast – all areas of significantly less precipitation. The two largest conveyance projects in California are the State Water Project (SWP) and the Central Valley Project (CVP). Both the SWP and the CVP use natural rivers and constructed conveyance facilities to deliver water from storage reservoirs in northern California to a broad array of agricultural water agencies in northern California and the

Source

CALFED Record of Decision and Conveyance Program http://calfed.ca.gov/

San Joaquin Valley, as well as urban water agencies in the San Francisco Bay area, central coast, and urban southern California.

In addition to state and federal facilities that move water from northern to southern California, a number of inter-regional conveyance facilities have been developed by local agencies in different regions. For example, East Bay Municipal Utility District and the San Francisco Public Utilities Commission have developed major conveyance systems that transport water from Sierra Nevada rivers directly to their service areas. The Los Angeles Department of Water and Power developed the Los Angeles Aqueduct to convey water from the Owens Valley to Los Angeles. A major source of water in southern California continues to be diversion and distribution of Colorado River water via: (1) the All American Canal serving the Imperial Irrigation District, (2) the Coachella Canal serving the Coachella Valley, and (3) the Colorado River Aqueduct delivering water to urban southern California. Each of these conveyance systems is a major contributor to each region's water supplies and overall water supply reliability.

Under the CALFED Conveyance Program, the CALFED Record of Decision calls out specific through-Delta conveyance actions that are to be either directly implemented or otherwise pursued including:

Increase SWP permitted pumping to 8500 cfs and install permanent, operable barriers in the south Delta

Increase SWP permitted pumping to 10,300 cfs and construct Clifton Court Forebay fish screens

Construct Tracy Fish Test Facility

Implement Lower San Joaquin River Floodways Improvements and Ecosystem Restoration Project

Old River and Rock Slough Water Quality Improvement Projects

Evaluate improved operational procedures for the Delta Cross Channel and simultaneously evaluate a screened through-Delta facility on the Sacramento River up to 4000 cfs

Implement North Delta Flood Control and Ecosystem Restoration Improvements Program

Consider the need for conveyance interties between the SWP and CVP in the vicinity of Delta Mendota Canal Mile Post 7 and between Clifton Court Forebay and the Tracy Pumping Plant

Continue the Temporary Barriers Project until permanent flow control structures are constructed

CALFED goals for Delta conveyance

- *Improve water supply reliability for in-Delta and export users*
- *Support protection and continuous improvement of drinking water quality*
- *Improve Delta ecosystem*

Evaluate a bypass to the San Felipe Unit at the San Luis Reservoir to reduce risk from the “low point” water levels in the San Luis Reservoir

Facilitate water quality exchanges and similar programs to make high quality Sierra Nevada water available to urban Southern California interests

Assist in implementation of the Sacramento and San Joaquin Comprehensive Study to improve flood control and ecosystem restoration

CONVEYANCE WITHIN REGIONS

The existing networks of inter-regional conveyance systems would not be capable of producing benefits if not for the ability of local water agencies to utilize conveyance to distribute imported, or locally produced, water to the end users (e.g. treated drinking water to residential or industrial users, irrigation water to agricultural users, etc). In fact, conveyance is necessary in order for benefits to occur with virtually every other facet of local water management (e.g. desalination, recycling, use efficiency, storage projects, etc).

Other conveyance activities at the local level (as well as the larger inter-regional projects) include environmental and recreation-related conveyance activities that can either be intentional or incidental to agricultural and urban water management activities. This could involve beneficiaries such as fish habitat (temperature, flow or quality improvements), riparian vegetation, rafting or recreational turf.

One current planning process that seeks to enhance its conveyance connectivity at the regional level is the ………

Benefits

It is important to recognize the crucial importance of adequate inter and intra-regional conveyance capacity to overall water supply reliability for all use sectors. The main benefits of conveyance (to the urban, agricultural and environmental water use sectors) are in maintaining or increasing water supply reliability, augmenting current water supplies, and providing water system operational flexibility. For the environmental sector, benefits include in-stream flows, appropriate temperatures and water quality for aquatic and riparian habitat.   Other specific benefits are as follows:

Conveyance is necessary for most of the other resource management strategies to be successful because as it moves water from the source to the urban, agricultural, and environmental end users.

oConveyance is needed to move water in water transfers between sellers and buyers.

In order for water to be developed by new groundwater or surface storage, diversion facilities must be capable of filling the storage. Also, facilities must then be in place to convey the storage releases to the users at the right times and flow rates.

Other benefits of conveyance improvements generally include:

Enhancement of flood control capability

Increases in water use efficiency

Increases in resiliency to catastrophic events

Water quality improvements

Reductions in operating costs

Improvements to instream and riparian habitat

It is important to recognize that improving water supply reliability through system flexibility is just as valuable as increasing overall supply. Indeed, conveyance capacity improvements can enhance reliability without augmenting supplies or reducing demand by increasing system operational flexibility. For example, conveyance is needed to accommodate the timing requirements of water deliveries – frequently within the framework of a competing, multi-purpose water management system.

Other specific examples include:

Conveyance improvements can provide the flexibility to divert and move water at times that are less harmful to fisheries.

Conveyance can improve water quality by moving more water when water quality conditions are better or less impacted by the movement of water.

o Given California's "flashy" natural drainage characteristic, improved conveyance capacities can divert more water "when the water is there" or during high flow/less competitive periods, and consequently reducing the pressure to divert water during low flow/highly competitive periods.

Potential costs

Conveyance costs can be a significant portion of the costs in a water management system. The cost of water conveyance heavily depends on the local circumstances, and how far and when the water needs to be conveyed. It costs considerably less to convey water from Oroville Dam to Yuba City in northern California (all gravity flow) than to convey water from Oroville Dam to the South Coast Region. Conveying water through the Delta and the California Aqueduct increases the water cost delivered south of the Delta by several hundred dollars per acre-foot. CALFED estimates of Delta conveyance improvements may cost about $1 billion to construct. However, until all alternatives for these facilities are fully evaluated, this cost is tentative.

Major issues

BETWEEN AND WITHIN A REGION

Maintenance – It is essential at a minimum to maintain the current level of conveyance capacity regarding both natural and constructed facilities, particularly with an increasing population and increased demands for water. This is likely to take on greater importance over time due to aging water infrastructure and the increasingly higher costs of maintenance. Also, increased awareness and sensitivity of environmental considerations will likely affect the need and cost of maintenance. While concerns are likely to focus on adequate financial resources to maintain conveyance infrastructure, there is the special case of diminishing conveyance capacity in natural watercourses. This is most critical from both a water conveyance and flood passage standpoint in the channels of the Delta.

Science – Water managers, planners and biologists continue to struggle to identify and understand the relationships between hydrodynamics, flow timing, fish timing and movement, water temperature, geomorphology, water quality, environmental responses, global warming affects and other conveyance related considerations so they can optimally plan, develop, operate and maintain natural and constructed conveyance infrastructure.

WITHIN A REGION

Public Policy –SB 672 requires that DWR acknowledge and consider water management alternatives that allow regions to be more self-sufficient (i.e. minimize dependence on additional imports).

Local and Regional Water Supply Reliability – Greater interconnections are needed to help improve water supply reliability, as evidenced by how California has responded during drought conditions. Each water system has its own level of water supply reliability, based largely on storage and conveyance systems, hydrology, and level of demand. More and more we are seeing larger water systems seeking to interconnect their systems to provide greater operational flexibility, particularly during emergency conditions.

BETWEEN REGIONS

CALFED Through Delta Strategy –The CALFED objective for the Conveyance Program employs a through-Delta approach to conveyance. The Conveyance actions proposed will involve the evaluation of alternatives which utilize existing Delta conveyance waterways and facilities to the maximum extent possible, and implement projects which are technically and economically feasible, environmentally sound and scientifically supported. Delta conveyance capacity and operational restrictions have been identified as a key bottleneck to improving the water supply reliability for in-Delta and water export users, and improving drinking water quality limiting the flexibility to realize these benefits. This lack of flexibility also limits the ability to take advantage of other water management strategies such as water transfers (including transfer of previously stored water), conjunctive management, groundwater storage, and north of Delta water use efficiency. A key challenge for the California Bay-Delta Authority is to develop a strategy that all stakeholders agree will provide the necessary flexibility to the system and be protective of water quality, Bay-Delta hydrodynamics, fisheries, and habitat.

Area of Origin Interest – Inter-regional movement of water is sometimes opposed by the source water counties. In addition to struggling to augment local water supplies to meet growing demands, area of origin interests often feel that the "downstream" water users could/should be more committed to managing the "natural infrastructure" (e.g. watersheds) from which their imported water originates.

Recommendations

Between and within a region are:

- Consider and implement feasible conveyance system operational changes before deciding to construct new or expanded conveyance facilities.
- Assure adequate resources to maintain existing conveyance facilities and capacity. This may include development of a strategy to maintain channel capacity in areas of the Delta.
- Promote development of more extensive interconnections among water resources systems such as, and in addition to, the SWP-CVP intertie or improved connectivity within the Bay Area Region. It is likely that leadership and funding on this will be at the local level.
- Develop and promote analytical guidelines that uniformly consider "supplemental" conveyance facilities required for benefits to accrue with from other strategies such as recycling, desalting, storage, conjunctive use, etc. (e.g. consider conveyance capital and O&M costs, implementation challenges, etc)

Within a region

- Line conveyance canals to reduce seepage if economical and if such actions don't conflict with groundwater replenishment objectives or environmental values (e.g. riparian habitat)

Between regions

- Financially support the CALFED through-Delta conveyance improvements per CALFED ROD.

Desalination

In Progress

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Drinking water treatment and distribution

The State of California has a role in ensuring the safety of the public water supply and the health of Californians who use it. Even after preventing pollution and matching water quality to use, drinking water supplies will generally still require some of level of treatment to achieve a potable level of quality, which will need to be maintained in a distribution system. Drinking water treatment includes physical, biological, and chemical processes to make water suitable for potable use. Distribution includes the storage, pumping, and pipe systems to deliver the water to the customers.

Current status

Pursuant to state Department of Health Services regulations, all surface waters in California must be filtered and disinfected, except for a small number, like San Francisco's Hetch Hetchy water supply, that meet DHS's filtration-avoidance criteria1. In general, basic surface water treatment consists of pretreatment, filtration through sand and gravel media followed by disinfection with chlorine. Many water suppliers, especially those in the San Francisco Bay Area, have already implemented more advanced treatment to improve water quality using processes such as granular activated carbon (GAC) for filtration and ozone and chloramination (a combination of chlorine and ammonia) for disinfection. In Southern California, the Los Angeles Department of Water and Power has disinfected Owens Valley water with ozone for the past 20 years. The Metropolitan Water District is in the process of upgrading to ozone disinfection at its five treatment plants, which use either Colorado River water or a blend of Colorado and Delta water.. UV radiation is a promising advanced disinfection technology, but has yet to be implemented in a large scale domestic water treatment facility in California. The integration of multiple disinfectants also shows promise in optimizing protection from microbiological contaminants in drinking water. Some smaller water treatment facilities use membrane filtration, which produces relatively high quality water. Water systems that rely upon groundwater generally only disinfect well water with chlorine, unless a specific contaminant is affecting the water's intended use.

Distribution system water quality is emerging as an important issue in the waterworks community, especially given recent heightened awareness of water supply security. Historically, treated water storage and

Sources

- Bay-Delta Water Quality Evaluation, *California Urban Water Agencies, June 1998*
- Drinking Water into the 21st Century; Safe Drinking Water Plan for California, A Report to the Legislature*, California Department of Health Services, January 1993*
- Households Without Potable Water Service, California 2002, *Department of Water Resources, 2002*
- *2000 US Census*
- *USEPA Drinking Water Program, http://www.epa.gov/safewater/*
- *USEPA Needs Survey, www.epa.gov/OGWDW/needs.html*
- *Congressional Budget Office, www.cbo.gov/execsum.cfm?index=3983&from=1&file=ExecSum.htm*
- *Water Infrastructure Network, www.win-water.org/*
- *City of Fairfield*
- *Metropolitan Water District of Southern California*
- *California Department of Parks and Recreation*

associated distribution systems were designed to meet fire suppression flow requirements rather than maintain system water quality. Threats to water quality in distribution systems include the introduction of contamination from cross-connections with non-potable water sources (like recycled water), uncovered storage, and water main repair and replacement, as well as the by-products of corrosion, lead, and re-growth of microorganisms. Ironically, the implementation of ozone for disinfection, while effective in killing microbes and generally forming fewer disinfection by-products, can create conditions that can encourage the growth of microorganisms in water distribution systems. Aging water system infrastructure (some well over 100 years old) in general is not being replaced or rehabilitated within the useful life of such facilities.

Legal framework

Refer to Chapter 2 for the legal and regulatory framework for drinking water treatment and distribution.

Small, rural water systems (those serving fewer than 3,300 service connections) face unique treatment and distribution challenges, primarily the lack of technical and financial capacity to adequately address water quality contamination. Such systems are often the most frequent violators of drinking water standards, and often must cope with some of the most difficult water quality constituents, such as arsenic, as well as more traditional but no less problematic contaminants such as nitrate and coliform bacteria.

Potential benefits

Many water contaminants potentially cause cancer, other life-threatening diseases, and dysfunction of the reproductive and endocrine systems; others can cause short-term gastrointestinal illnesses, resulting in lost work and school days. Improved water quality can directly improve the health of Californians, thereby improving the state's standard of living and reducing the burden and costs on the state's healthcare system. If poor water quality causes a need for medical treatment by many uninsured Californians, the costs will be borne by State health programs (e.g., MediCal), which directly impacts the state budget. In addition, many consumers who choose to purchase relatively expensive bottled water or home treatment units, could save more of their personal budgets if they instead used tap water.

USEPA has proposed new regulations to reduce both the gastrointestinal and carcinogenic disease risks of drinking water. The agency estimates that the Long Term 2 Enhanced Surface Water Treatment Rule will prevent over a million cases of cryptosporidiosis and up to 140 premature deaths annually, providing $1.4 billion in benefits. USEPA also estimates that the Stage 2 Disinfection Byproducts Rule will prevent up to 182 cases of bladder cancer per year, providing nearly $1 billion in benefits. The combined costs to almost all households of these two proposed regulations are less than $24 per year.

Potential costs

Advanced water treatment itself is a relatively low percentage (on the order of 1 percent) of a customer's overall water bill. For example, the 40 million gallon per day (MGD) North Bay Regional (NBR) Water Treatment Plant (which serves Fairfield and Vacaville) treats a blend of Lake Berryessa and Delta water with GAC and ozone. The operations and maintenance expenses of these processes cost $0.04 per 1,000 gallons, on a total metered charge of $3 per 1,000 gallons. As another example, the Metropolitan Water District of Southern California estimates that its capital upgrade to ozonation will cost approximately $83,000 per acre-foot per day of capacity, with operations and maintenance costs of $9-12/acre-foot (equal to $0.03 to $0.04 per 1000 gallons, consistent with O&M costs at NBR). Nonetheless, despite the relatively low costs, economies of scale negatively affect small water systems that have a smaller rate base to spread both capital and O&M expenses.

As for infrastructure, the USEPA estimated in October 2002 that over the next 20 years there would be a $535 billion funding gap nationally for water and wastewater infrastructure. The drinking water estimate alone was $265 billion, covering both capital and operations and maintenance costs. The following month, the Congressional Budget Office issued its own estimate of at least $25 billion (2001 dollars) annually for the same time period, consistent with EPA's figures. EPA estimates California's drinking water infrastructure needs at approximately $1 billion annually over the next 20 years. EPA also predicted that per household costs to small water systems will be four times that of customers of large water systems (those serving more than 50,000 persons).

Major issues

Access to safe drinking water — The 2000 US Census indicates that over 85,000 households in California (or about 0.7 percent) lack complete plumbing facilities, which can include access to safe drinking water. In lieu of a connection to a public water system, many of these households may be obtaining their drinking water from shallow wells, springs, rivers, or hauled water supplies that are vulnerable to contamination. Moreover, many other households and schools, often in rural or low-income areas, are connected to small water systems that are less scrutinized by regulatory agencies. These small systems usually have limited funds and staffing to pursue improvements in drinking water quality, including preparation of grant applications.

Emerging contaminants – New contaminants are often discovered and then regulated because of increased pollution, improved analytical abilities, and better understanding of health effects. For instance, as the state's population ages, there may be increasing levels of pharmaceutical discharges in domestic wastewater and to the environment. In addition, the health effects of many known contaminants are re-evaluated—and re-regulated—because of new information about their health effects. For many emerging contaminants, there may not yet be treatment technologies available to remove them from drinking water. For such contaminants, only pollution prevention, or matching water quality to use, will adequately address water quality. For other contaminants, treatment options may be available, such as membranes, but they are relatively expensive.

Demographic changes; risk – There are increasing numbers and proportions of immunocompromised individuals, as well as children and elderly, who are more susceptible than the general population, to the risks of waterborne disease and exposure to contaminants. At the same time, water agencies are responding to regulatory signals that require control of disinfection byproducts in treated surface water. Depending upon the treatment scheme employed, measures to reduce the probable long-term risks of cancer can be at odds with efforts to protect the public from known short-term risks from microorganisms.

Contaminant interactions and cumulative effects - There is growing concern about the interactions and cumulative effects on human health of multiple contaminants in drinking water. Such effects are not addressed by current drinking water standards, which only regulate contaminants on an individual basis. The CALFED Drinking Water Quality Program is attempting to address this concern via its "Equivalent Level of Public Health Protection" strategy, which looks comprehensively at the total concentration of contaminants in drinking water, and integrates pollution prevention, alternative water sources, and advanced treatment to reduce them.

Recreation – The State Department of Parks and Recreation projects an increasing demand for recreation on reservoirs, including drinking water terminal reservoirs, such as Lake Perris in southern California. An increase in reservoir contamination, especially microbiological, from recreation can correspondingly increase the requirements of the treatment processes, in the treatment plants that a drinking water terminal reservoir feeds, and negatively affect the quality of tap water produced from these lakes.

Public distrust – Public opinion surveys consistently suggest that Californians, across all socioeconomic groups, poorly perceive and even distrust the quality of their tap water, often because of tap water taste, odor, or appearance, choosing instead to rely upon home treatment units and bottled water. Improvements in water quality may not effect the intended improvements in public health if the public is not drinking the water. Further, the public may not have complete information about the relative safety of bottled and tap waters, and may be misplacing their trust in sales pitches for bottled water and home treatment units. In particular, students may be bypassing tap water in schools in favor of less healthy beverage alternatives.

Affordability – Even though water treatment is a relatively small portion of a customer's water bill, increased costs are a concern for significant portions of the population. As costs increase, the relative burden on the household budgets of poor families will increase at rates greater than that of the general population. Moreover, the waterworks industry generally lacks lifeline rates for poor customers relative to other utilities (such as gas, electricity, and telephone). Alternatively, for those economically disadvantaged consumers that choose to purchase bottled water, money spent on that commodity may be better spent on other life necessities.

Recommendations

- All Californians should have access to safe drinking water. Thus, the state should assist in funding drinking water and wastewater infrastructure needs in areas, including on tribal lands, without piped domestic water and therefore not covered by the state and federal Safe Drinking Water Acts.
- The state, local water agencies, and non-profit organizations should better educate the public about the actual and perceived risks of tap water, bottled water, and water produced by home treatment units. State and local water agencies should specifically improve outreach and communication with vulnerable populations that may be at a higher actual level of risk of waterborne disease or other health effects from drinking water contaminants.
- Communities should have useful access to, knowledge of, and

engagement in drinking water quality monitoring and assessment. In addition, decision-making at all government levels should be transparent and involve affected communities, tribes, and general purpose local governments. Examples of vehicles for such access, knowledge, and engagement include citizen water quality monitoring programs, and water quality community advisory committees, at the local water system level.

- The state should increase the set-aside for technical assistance and capacity building within the Drinking Water State Revolving Fund to the maximum allowed by EPA for these purposes. Systems that serve large proportions or numbers of vulnerable populations, such as schools, should receive funding priority. The state should increase its formal partnerships with non-governmental organizations that are experienced in assisting small water systems in grant and loan applications, in order to reduce the bureaucracy separating community access to information and funding, address the most pressing public health risks, as well as ensure an equitable distribution of grant and loan funds.
- The state should implement guidelines for the design and operation of distribution systems to maintain system water quality. As a part of these guidelines, the state should ensure that public water systems are prepared for natural and man-made disasters, and are able to reliably maintain or quickly restore water quality in the aftermath of such disasters.
- Water utilities must prevent possible cross-contamination of potable water from dual-plumbing of potable and recycled water distribution systems and other non-potable sources.
- The state should monitor and resolve potential health impacts of indirect potable reuse of recycled water and other source waters for domestic use. The State Water Project and local agencies should only permit forms of recreation on terminal reservoirs that do not endanger the public health of those who drink the water produced from those reservoirs.
- The state should coordinate its funding sources (such as the Drinking Water and Clean Water State Revolving Funds) in order to address projects with multiple benefits – such as drinking water supplies threatened by contamination from septic systems.

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Economic incentives policy

Economic incentives policy comprises the use of water rates paid by users and subsidies (rebates, loans, grants, and free services) to influence water use and management. Water rate policy, subsidy policy, and which costs of providing water service are recovered through water rates are all interrelated. In general, the higher the incremental cost of water to users, the more likely they will be to reduce their use. Conversely, lower water rates charged to users can influence them to accept a source of supply they would otherwise find too costly, such as desalted ocean water. These lower rates can be allowed by the recovery of some water service costs from subsidies rather than the water users.

Current status

Existing water rate policy is for water agencies to recover the direct water management costs based on the share of those costs intended to be recovered through the water rates. (This share depends upon other means which may be used for cost recovery, including ad velorum taxes, for example.) The direct costs can, however, include contributions to capital investment accounts for funding anticipated projects.

Traditionally, costs to be recovered are those planning, capital investment, and operations costs directly incurred to develop, treat, and deliver water from a supply project or to implement a conservation program or project. Such costs include any required environmental mitigation. A policy decision could be made to expand costs to be recovered to include all external costs such as third party economic costs and unmitigated environmental or cultural costs.

Rate structures designed to recover these costs can be fixed, uniform, or tiered. Both uniform and tiered rates can have a fixed component. Where water is unmeasured, only fixed rates are feasible. Water measurement can take a number of forms, however. At the least, rates can differ based on connection size for urban users or on acreage and crop type for agricultural users.

Today, where water is metered, most urban water agencies have moved to at least uniform rate structures that increase water cost with water use; the more you use, the more you pay. Some urban agencies have adopted tiered rate structures that increase unit cost with water use; you pay more at an increasing rate. Some of these tiered rate structures may have even higher seasonal rates (e.g., Los Angeles Department of Water and

Sources

- *CUWCC. "Setting Urban Water Rates for Efficiency and Conservation, a Discussion of Issues". October 1994.*
- *City of Los Angeles. "A Consensus Approach to Water Rates". June 1992.*
- *USBR. "Incentive Pricing Handbook for Agricultural Water Districts". April 1997.*
- *Reason Foundation. "Water-Utility Regulation: Rates and Cost Recovery". March 1993.*
- *Federal water recycling grant program.*
- *State conjunctive use, water use efficiency, and water recycling grants and loans programs.*
- *MWDSC Local Resources Program.*

Credit

1999 California Water Charge Survey, Black & Veatch Corporation.

Power). As of 1999, of 326 California urban water purveyors surveyed, about 45 percent had tiered rates, about 42 percent had uniform rates, about 11 percent had flat or other type (e.g., number of rooms) rates, and about 2 percent had declining block rates. Also, urban agencies are moving to incorporate more cost recovery into the volume dependent portion of the water bill and away from fixed charges or fees. Some agricultural agencies such as the Central California Water District and the Panoche, Pacheco, and Broadview Water Districts have adopted tiered rate structures. These agencies are particularly interested in drainage water management.

CALFED, the Department of Water Resources, and the State Water Resources Control Board are administering subsidies in the form of low-cost loans and grants programs to encourage agricultural and urban water conservation, urban water recycling, agricultural and urban groundwater storage, and conjunctive use projects. Bond funds have been used for programs by local agricultural water agencies to help farmers finance on-farm conservation, including tailwater recovery systems and by local urban agencies to fund toilet rebate programs for residential users.

At the wholesale agency level, the Metropolitan District of Southern California has recently developed plans to expand its Local Resources Program, which provides a subsidy of up to $250 per acre-foot to its member agencies to encourage the development of water recycling, groundwater recovery, and seawater desalination. MWDSC charges a “water stewardship rate” to all its customers in order to be able to subsidize individual retail agency programs that have wider benefits.

Potential benefits from economic incentives policy

A major water management benefit that can result from economic incentives policy is water demand reductions that may produce environmental or social benefits and avoid or delay the need to construct costly water supply projects. However, its contribution depends on how much water use reduction has already been accomplished because of conservation education programs, plumbing codes, new appliance standards, reaction to shortage events, or previous rate increases, etc.

Higher water rates can encourage less water use. Rather than pay the higher water bill, users may find it less costly to them to: (1) forego less valuable uses for water (e.g., for sidewalk cleaning) or (2) incur the cost of adopting more efficient water using methods or technologies (e.g., purchasing a horizontal axis clothes washer). Water rate increases or subsidies can result in the adoption of agricultural or urban water management practices that result in beneficial changes in the timing and place of diversions and/or water quality even with only a minimal reduction in the net use of water on a system-wide basis, depending on location. Water rate policies that lower the cost of surface water during times of plentiful surface supply can encourage storage in groundwater basins, either by direct recharge from spreading basins or “excess” application on farm crops, or by in-lieu recharge by switching from pumping to surface deliveries. Incentives can also include rebate programs for low-flush toilet installation, free water audits for residential landscape water management, or free mobile lab services for increasing on-farm water use efficiency, for example.

Marginal cost pricing is one strategy to promote water use efficiency. In its purest form, marginal cost rates will be such that all users are charged as if they were paying for the full cost of the last (and, most probably, the most expensive source of supply). In a less severe form, the average cost of an additional supply needed would be reflected only in the rates of the water users whose “arrival” prompted its development (e.g., residents of new subdivisions).

Subsidy policies that encourage the adoption of specific types of local water management actions, either supply augmentation or demand reduction projects or programs, can result in important regional and statewide benefits that might not otherwise be realized. Groundwater supply programs that benefit all overlying users and produce general environmental benefits by reducing demands on the Delta fall into this category. Such directed subsidy programs can allow projects and programs to proceed without the lengthy and complex joint planning effort to identify all beneficiaries and determine cost recovery.

Economic incentives policy can also be used to influence the development of preferred water supply projects or programs. Such projects or programs might be preferred because they provide regional or statewide benefits, such as decreasing the demand for Delta exports. For example, a grant of state funds can be used to lower the effect of cost recovery for water recycling on water rates. This can make a recycling program attractive to the ratepayers that would otherwise not be cost-effective from their viewpoint. Similarly, a wholesale water agency might make available financial incentives to encourage individual member agencies to undertake projects or programs that would benefit all member agencies.

Quantifying the total potential water amounts provided by economic incentives is difficult. Incentives act indirectly by influencing the adoption of strategies which directly affect the management of water.

Determining potential water quantities would require assumptions about what strategies would result from those incentives and the quantities of water that would be involved.

Potential costs

In the narrowest sense, the only direct cost of an economic incentive program is the cost of its administration. All other costs are associated with the water management strategies that the incentives policies may cause to be implemented. Determining potential costs of economic incentives would require assumptions about what strategies would result from those incentives and what they would cost.

If marginal cost pricing is used, for example, the unit cost to water users could rise dramatically in some areas. If costs are over-recovered, the over-recovery represents a transfer of wealth from water users to water agencies but not an economic cost. Using the unit cost of ocean water desalting in the South Coast Region as a benchmark, marginal cost pricing could double the unit cost to water users in that region. Like other strategies, water rate policy will need to be specific to each water agency. In any case, marginal cost pricing could raise rates to customers by several billion dollars annually statewide. If third-party and unmitigated environmental and social costs were included in the marginal cost calculation, the cost impact would be much higher.

Increased water rates can impose costs on water users directly, by the additional payment required, or indirectly, by 1) causing a decision to forego less valuable (but not worthless) uses for water, 2) causing the user to bear the cost of more efficient water using methods or technologies.

The costs of subsidies needed to encourage the adoption of preferred water management strategies could vary from a small percentage to the full cost of those strategies, depending upon the financial incentive expected to be required for their implementation.

Major issues

Selecting Appropriate Economic Incentives Policy – A major issue in developing a water rate policy is deciding what rates to charge the water users while ensuring that costs of delivering the water are recovered. The design of water rates involves assumptions about user responses to water price that may not be accurate. Managing water rate changes during water shortages can be challenging since incremental costs of supply can increase dramatically and change rapidly, making it more difficult to recover costs. If marginal pricing is to be used, how should the appropriate marginal cost be determined? Should everyone pay the marginal costs or just certain segments of the user population? What happens when revenues exceed cost recovery requirements? If subsidies are involved, what is the best method to allocate available funds among groups competing for those subsidies? How should Public Trust and Environmental Justices issues be addressed? How can water agencies with dramatically different resources be assured of an equal opportunity to compete for funds?

Funding for subsidy programs – Availability of state funding can be intermittent. Funding methods that require direct legislative appropriation or approval of new water bonds could require several years lead time before funds are available.

Criteria for Subsidy Funding Approval – Given the increasing need for the implementation of water management strategies and their associated costs, requests for subsidy funds will likely exceed available funding. Deciding which strategies and which agencies receive subsidy funding will require development of ranking criteria to provide for the appropriate allocation of funds while considering economic efficiency, equity, and environmental protection.

Social Considerations – How does an economic incentives policy deal with social equity issues (e.g. ability to pay affects willingness and ability to participate)? An equity issue also arises when those incurring the costs of subsidization through taxes or fees do not receive a "fair share" of the broader benefits that the subsidies may be expected to generate. While agricultural water pricing can increase the efficiency of on-farm water use, resulting in shifts to lower water-using or higher-revenue crops, it can also make land unprofitable to farm. Communities dependent on farm production may be disproportionately affected. If water rate changes reduce the use of ornamental landscaping, jobs that depend on establishing and maintaining that landscaping could be lost.

Financial Safeguards – Some safeguards are needed to assure that the entities receiving the subsidies are financially secure and that the funds are used for the purposes for which they were allocated.

Regulations – Some water agencies currently are not permitted to collect revenues in excess of costs. Changes in regulations may be needed to implement a water pricing policy that works best for an agency. Some water agencies have regulations that prevent the use of water metering necessary for measuring and pricing volumes of water. Typically, loans and grants are constrained by bond language to strategies that lead to capital expenditures and may not be used for developing non-capital strategies like water rate policy.

Recommendations

The state and water agencies should consider and evaluate economic incentives using the same social, environmental, and economic cost and benefit criteria as those used for other potential management strategies. The following recommendations recognize that economic incentives policies will vary widely throughout California due to differences in local conditions:

- Institute water rate policies that support better water management based on the unique conditions in each water district.
- Implement appropriate measurement of all water uses in California, including urban metering in accordance with the recommendations of CALFED appropriate measurement workgroups.
- Use tiered pricing to the extent that it improves water management, including consideration of higher prices for water in excess of agricultural and urban vegetation management requirements.
- Move as much of cost recovery from sources of revenue not related to water use (e.g., ad velorum taxes) and fixed water charges to variable charges in water rates as is financially prudent.
- Institute pricing incentives that encourage the sustainable use of groundwater.
- Institute pricing incentives that reduce excessive deep percolation of water in agricultural drainage problem areas.
- Agencies adopting new water rate policies should clearly identify what they mean to water users and provide education, training, and technical assistance to water users to maximize the desired outcome of those policies.
- Institute subsidy policies that support better regional and statewide water management based on the unique conditions in each water district.
- Develop ranking criteria for grant and loan awards to water agencies that consider economic, environmental, and equity issues, economic hardship, public trust, environmental justice, and the regional and statewide distribution of benefits in allocation of

subsidy funds.

- To avoid disadvantaging some local agencies, the grant and loan award process should account for the fact that some water agencies have limited funds and staffing to prepare applications.
- Agencies receiving grants and loans should make information on the success of the programs/projects that they implement available so that the experience can be used to design better subsidy plans.
- The state should provide technical assistance to local agencies in developing equitable and effective economic incentives policies.
- The state should assist local agencies in using planning methods that maximize economic efficiency on a regional and statewide basis.

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Ecosystem restoration

In Progress

Floodplain management

Historically, flood control efforts in California aimed at keeping rivers in their channels and off their floodplains, chiefly through the use of levees and upstream impoundments. Yet, flooding is an important natural function of rivers. Seasonally-inundated floodplains provide essential habitat for hundreds of species of plants and animals, many of them dependent on periodic floods. There are also economic, agricultural and societal benefits to maintaining connections between rivers and their floodplains. Floodplain management is a term used to describe actions on the floodplain intended to provide benefits to natural resources and, at the same time, reduce risks to life and property. Examples of such management activities include realignment of levees, reconnection of historical floodplains, re-operation of reservoirs and re-establishment of meander corridors.

The current condition of floodplain management

In the past, many projects within floodplains were developed to carry out single-purpose objectives, without considering the importance of flooding in maintaining a healthy natural environment. Likewise, some ecosystem restoration projects were carried out without sufficient consideration of long-term floodway maintenance requirements. Such single-purpose projects are no longer considered the preferable approach. Instead, governmental agencies and the private sector are likely to garner the resources and public support for projects only if they achieve multiple benefits. Several examples of this shift in approach are given below.

A voter-approved bond issue, Proposition 13, authorized funds for a flood protection corridor program. The program supports projects that provide non-structural flood control and either preservation of agricultural land or preservation or enhancement of wildlife habitat. A second bond issue, Proposition 50, contains additional incentives for watershed-based management approaches.

In 2000 the Governor signed AB 1147, which provides significant financial incentives for multi-purpose flood management projects that address ecosystem and recreational needs. AB 1147 also recommended the creation of the California Floodplain Management Task Force. In February 2002, the Governor delegated authority to DWR to convene the Task Force. With broad membership from government and stakeholders, the Task Force looked for ways to reduce flood damage and maximize the benefits of floodplains. The Task Force submitted its report in December 2002, with numerous recommendations to promote multi-objective management of floodplains.

The priorities of the CALFED Ecological Restoration Program include restoration of floodplain habitat, riparian corridors and dynamic river processes such as meander belts. The ERP identifies opportunities to mimic natural flow regimes through reservoir releases; mimic natural flows of sediment and woody debris; and provide sufficiently high flows to inundate floodplain surfaces. The program recognizes that reconnection of rivers with their floodplains may be essential for recovery of numerous at-risk species.

An example of successful multi-objective floodplain management is in the Yolo Bypass. The Bypass was established for use as a floodwater corridor in the floodplain of the lower Sacramento River basin. It is also intensively cultivated outside the flood season, and its rice fields double as habitat for waterfowl and wading birds. Parts of the Bypass are managed for outdoor recreation, including hunting and fishing. Portions have been planted to riparian forest, with no loss of flood-carrying capacity. Management of the floodplain also provides spawning and rearing areas for native fishes.

Benefits

Floodplain management can provide a wide array of ecosystem, economic and health and safety benefits. Floodplain management can improve ecosystem functions, reduce potential for loss of life and reduce flood damages to property by encouraging sustainable land use decisions along river corridors. By making better land use decisions, more open space (agriculture and native habitats) could be maintained. Controlling development within the floodplain, and even removing some damageable property from the floodplain, can significantly reduce potential future flood risk to people and property. Periodic inundation of the floodplain can provide rearing habitat that favors native fishes over exotics. Floodplain management that reconnects the river to portions of the floodplain can increase geomorphic processes, provide for more diverse habitats, and allow a restored ecosystem that is self sustaining. This reconnection of the river with its floodplain can also increase groundwater recharge, benefiting groundwater supplies and water management.

Costs

Issues

Floodplain connectivity and inundation- Common flood management and erosion control measures, such as levees and bank armoring, separate river channels and flows from historic floodplains. The connection between the river and its floodplain, and the occasional inundation of the floodplain, is often a prerequisite for the creation of good habitat. A challenge for floodplain and riparian restoration is to reconnect the floodplain with the stream and still prevent damage from floods and soil erosion. This is especially difficult and costly where houses, highways, and other encroachments reduce flood-carrying capacity.

Restoration of large river flows is constrained on rivers with dams where regulated maximum release levels are too low to produce desired results

Single-Purpose Approach to Floodplain Management – Flood managers are inclined to pursue single-purpose projects because they have the requisite expertise and because such projects seem expedient. Integration of multiple objectives, including public safety, flood damage reduction, agricultural conservation and ecosystem protection and restoration, requires more knowledge, more time and collaboration among diverse interests.

Recommendations

The state should follow the recommendations of the December 2002 report of the Flood Plain Management Task Force. They include:

- In planning new or upgraded floodwater management programs and projects, including structural projects, local and state agencies should encourage, as part of the design, where appropriate, non-structural approaches and the conservation of beneficial uses and functions of the floodplain.
- The state should identify, develop and support tools to protect flood-compatible land uses. These tools should be developed in consultation with, and be available to, private landowners, local governments and non-governmental organizations.
- When land is considered for use in a flood management project or program, the following should be addressed equitably: (a) conserve productive agricultural land and natural habitat; (b) promote the

recovery and stability of agriculture; (c) promote the recovery and stability of native species and overall biotic community diversity; (d) provide for natural, dynamic hydrologic and geomorphic processes; (e) increase and improve the quantity, diversity and connectivity of native habitat; (f) eliminate or mitigate negative redirected impacts to neighboring landowners; and (g) evaluate and address economic impacts to local communities and regions.

Matching water quality to use

Matching water quality to use is a management strategy that recognizes that not all water uses require the same quality water. One common measure of water quality is its suitability for an intended use, and a water quality constituent is often only considered a contaminant when that constituent adversely affects the intended use of the water. High quality water sources can be used for drinking and industrial purposes that benefit from higher quality water, and lesser quality water can be desirable for some uses, such as riparian streams with plant materials benefiting fish. Further, some new water supplies, such as recycled water, can be treated to a wide range of purities that can be matched to different low and high quality uses. The use of other water sources, like recycled water, can serve as a new source of water that substitutes for uses not requiring potable water quality.

Current status

SWRCB has identified 23 beneficial use categories of water, for mostly human and in-stream uses. Human uses can be categorized as consumptive (e.g., municipal, agricultural, and industrial supplies) and non-consumptive (e.g., navigation, hydropower generation, and water contact and non-contact recreation). Matching water quality to most of these uses is important because, except for municipal and industrial uses, water is generally used as-is, without treatment.

Farmers currently match crops to the available water quality. In general, irrigation water should contain levels of constituents such as salinity and boron that will not inhibit the yields of some crops. Conversely, agricultural water supplies that have low levels of salts may require adding gypsum to improve percolation. Agricultural water supplies that are turbid may require sand filtration to remove particulate matter that could clog drip irrigation systems. Imperial Irrigation District utilizes silt removal basins to clarify Colorado River water before it can be used for irrigation.

Alternatively, ambient in-stream water must be suitable to support a wide range of aquatic habitats and conditions. Thus, water quality for in-stream uses generally must be free of a variety of contaminants, not just a few. One particular pollutant that affects fisheries is temperature. An example of an effort made to match water quality to an environmental use for that particular pollutant is the Temperature Control Device at Shasta

Sources

- Down the Drain, *Environment California Research and Policy Center*
- *Water Quality Program Plan, CALFED Bay Delta Program, July 2000*
- Addressing the Need to Protect California's Watersheds: Working with Local Partnerships, *The Resources Agency and State Water Resources Control Board, April 2002*
- Salinity Management Study, *US Department of the Interior and Metropolitan Water District of Southern California, June 1998*
- *Sacramento River Watershed Program*
- *Alameda County Water District*

Dam, which was constructed to better match water temperature to the reproductive needs of salmonid fish downstream.

For drinking water supplies, it is important to start with the highest quality source water possible. Historically, California's urban coastal communities, Los Angeles, San Francisco, Oakland and Berkeley, constructed major aqueducts to such sources (Hetch Hetchy, Owens Valley, and the Mokelumne River). Later, water supplies of lesser quality, such as the Sacramento-San Joaquin Delta and the Colorado River, were also tapped for domestic water supplies. In response, many utilities already manage water quality by blending higher quality water supplies with those of lower quality, as well as matching treatment process to source water quality, as required by regulation. For example, Metropolitan Water District of Southern California dilutes high salinity Colorado River water with lower salinity water from the Bay-Delta — which in turn dilutes the higher organic carbon levels in Delta water with Colorado River water containing lower levels of organic carbon. In Solano County, higher quality, less variable Lake Berryessa water is blended with lower quality, highly variable North Bay Aqueduct water from the Delta. Likewise, many water suppliers have the capability to blend groundwater, local surface water, and imported supplies to achieve a desired water quality, although some utilities currently may instead choose to use water supplies based upon cost minimization or water rights. Some water agencies even blend water (and water quality) from different levels of the same reservoir, by using different intake levels. Many water management actions, such as conjunctive use, water banking, and water transfer programs, intentionally or unintentionally, result in one type of water quality traded for or blended with another.

Business also matches water quality to use. For instance, Silicon Valley manufacturers and other businesses in the San Francisco Bay Area prefer higher quality Hetch Hetchy water to Delta or groundwater supplies that are also available in the region. For other uses, lower quality waters can be used. Cooling water used in production processes is often of a lower quality than that used for drinking. Alternatively, water used in high-technology applications is often purer than that used for drinking. The Central and West Basin Municipal Water Districts offer different qualities of recycled water—at different costs—tailored to different uses, including process water for petroleum refining. At least one concrete plant, located in San Francisco, captures and reuses its stormwater water runoff for concrete production.

Two proposed projects, the San Joaquin Valley-Southern California Water Quality Exchange Program, and the Bay Area Water Quality and Supply Reliability Program, are proposed under the CALFED program, to improve water quality and water supply reliability, as well as disaster preparedness. These programs could promote matching water quality to use, with potentially no degradation to the ultimate use of the water. For example, in the Bay Area, a local water agency with access to a water supply of relatively lower water quality, could fund water recycling and/or water conservation projects in another agency's service area that has a higher quality water supply, in exchange for the higher quality water saved by those projects. Under the San Joaquin Valley-Southern California Water Quality Exchange Program, Metropolitan is working with both the Friant Water Users Authority and the Kings River Water Association to investigate the feasibility of exchanging water supplies. Metropolitan is interested in these exchanges to secure higher quality Sierra water supplies that could result in treatment cost savings and increased ability to meet more stringent drinking water quality regulations. Friant and Kings are interested in securing infrastructure improvements, financed by Metropolitan, which will increase water supply reliability for their members, in return for participating in the water quality exchange. Nonetheless, water quality exchanges could have third-party impacts, such as increasing the salinity of local groundwater, reducing the availiability of higher quality in-stream water needed for fisheries, and limiting agriculture to salt-tolerant crops. For drinking water, the exchange could also trade bromide and organic carbon, precursors to contaminants with probable risks, for arsenic, one of the few known carcinogens in drinking water.

More information

More information on this watershed-based approach can be found in the Pollution Prevention and Watershed Management narratives.

Potential benefits

For agricultural and in-stream uses, water quality matching is an integral part of water management, because there is generally no treatment of these water supplies prior to their use. For drinking water, appropriately matching high quality source waters can reduce the levels of pollutants and pollutant precursors that cause health concerns in drinking water. In addition, less costly treatment options can be utilized when water utilities start with higher quality source waters, and water supply reliability can also be enhanced.

For municipal and industrial customers, using water high in salinity can cause economic costs through damages to plumbing and water-using devices, equipment, and fixtures. One study, conducted in 1998 by the U.S. Department of the Interior and the Metropolitan Water District of Southern California, found that for every 100 mg/L decrease in salinity, there is an economic benefit of $95 million annually to Metropolitan's customers.

Improved treated water quality and water supply reliability are also potential benefits of water quality matching for those agencies that have access to a diverse water supply portfolio. One example is the Santa Clara Valley Water District, its retail agencies, and other water suppliers along the South Bay Aqueduct, which have access to Delta water, Hetch Hetchy, local surface water, and groundwater. During droughts, seawater intrusion increases the level of salinity in Delta water supplies, including bromide. In such an event, agencies and regions with water source flexibility could utilize more groundwater or local surface water (if available), both of which are relatively bromide free and thus do not create bromate, a potential carcinogen, upon disinfection with ozone.

Potential costs

Water that contains lower levels of salinity is a better match for domestic water quality uses and for irrigating salt-intolerant crops such as strawberries and avocados. As noted, some agencies blend water supplies to achieve a desired water quality, including salinity. However, should low salinity water supplies from the Bay-Delta be unavailable, water utilities may instead have to treat high salinity water supplies to achieve their desired water quality. In the Chino Basin, utilities already demineralize (desalt) water for domestic use, and Zone 7 Water Agency and Alameda County Water District (ACWD), both in the San Francisco Bay Area, have similar plans. At ACWD, for example, the capital costs alone of a new groundwater desalting project to be completed this year in Newark will have capital costs of $800,000 per acre-foot per day of capacity, with operation and maintenance costs of $500 per acre-foot. In some cases, costs for matching water quality to use will also include new conveyance systems to connect to different source waters.

The primary costs of water quality exchanges are: infrastructure, conveyance (e.g. energy, capacity, hydraulic losses) and incentive payments for participants (i.e., the incentive driving the Friant/Kings-Metropolitan Programs is Metropolitan's willingness to invest in local infrastructure that will benefit the exchange partner). Recently, however, a "no-cost" water quality exchange was implemented between the Environmental Water Account (EWA), Kern Water Bank, and Metropolitan. Under the exchange, EWA had purchased groundwater in Kern Water Bank and was seeking to avoid a storage fee for leaving the purchased water in the Bank. Metropolitan offered to receive EWA's purchased water in exchange for providing the EWA with a surface water supply later in the year when EWA could utilize the water. Metropolitan benefited from the exchange because it received groundwater supplies with low total organic carbon and bromide levels during a period when Metropolitan was unable to blend total organic carbon levels down with Colorado River supplies. Other “no cost” exchanges are being explored that are similar to this arrangement. One example is for an urban water user to provide agricultural water users with surface supplies during the peak agricultural water demand period, when agricultural users are forced to use groundwater and may be facing pumping constraints. In return, the agricultural user would return a like amount of pumped ground water during the fall-winter period when bromide and total dissolved solids in Bay-Delta supplies are higher.

Major issues

Many of the issues of matching water quality to use are integrally connected to source water protection.

Water transfers — Water quality exchanges face similar regulatory, institutional, and third-party impact issues that water supply transfers face (please see the Water Transfers narrative for a discussion of those issues).

Place-of-use restrictions – Water supplies are generally governed by place-of-use restrictions that must be addressed when exchanging water supplies. For many of the farmers using high quality Sierra water supplies, the prospect of approaching the SWRCB to change the place-of-use, even temporarily, is a problem.

Unusable water – There is a high cost incurred by water supplies that are either unsuitable for certain uses, or very expensive to use, because of contamination. One specific example, cited in a recent study by the Environment California Research and Policy Center, is the contamination by methyl tertiary-butyl ether (MTBE, a gasoline additive that may cause cancer) which initially closed 80% of Santa Monica’s drinking water wells, in turn forcing that city to increase its dependence on imported water sources, and later to install treatment to reduce MTBE levels. More generally, nitrate has closed more public water supply wells in California than any other contaminant, often redirecting the use of such contaminated water to irrigation.

Salinity — Agricultural drainage, imported Colorado River water, and seawater intrusion in the Delta and coastal aquifers all contribute to increasing salinity in all types of water supplies, which can adversely affect many beneficial uses, including irrigation, fish and wildlife, and domestic use. The primary tool to reducing salinity is matching water quality to use, because many sources of salinity (e.g. seawater intrusion) are natural, and treatment to remove salinity is relatively expensive. Further, water supplies that are high in salinity increase the cost of recycling and/or recharging these supplies in aquifers for subsequent re-use.

Operations criteria for storage and conveyance – Water quality currently plays a relatively minor role in the operation of most local, state, and federal water projects. Most reservoirs and other projects, such as water transfers and the Environmental Water Account, are operated to achieve goals and objectives related to water supply, power production, flood control, fish and wildlife protection, and even recreation—but not water quality. In the Delta, the only water quality standards for project operations are for salinity, to protect agricultural, in-stream, and municipal and industrial uses. Other parameters of concern for domestic uses, such as pathogens and organic carbon, do not have operating criteria.

Upstream and downstream partnerships – Presently, few partnerships exist between upstream source water areas, downstream water users and the water users in between that affect water quality, resulting in a critical disconnect in the overall system.

Recommendations

- The state, local water agencies, and regional planning efforts should manage water supplies to optimize and match quality to intended uses and available and appropriate treatment technology.
- Consistent with the watershed-based “source-to-tap” strategy recommended in the Pollution Prevention narrative, the state should facilitate system-wide partnerships between upstream watershed communities and downstream users along the flow path, to seek ways to better match water quality to use; one such example is the Sacramento River Watershed Program.[1]
- The state should facilitate and streamline water quality exchanges that are tailored to better match water quality to use, while mitigating any potential third-party impacts of such transfers, as well as ensure that place-of-use issues are addressed in a manner that protects an exchange participant’s water rights.
- The state and local agencies should better incorporate water quality into reservoir, Delta, and local water supply operations, as well as facility re-operation. For example, the timing of diversions from the Delta, and thereby the concentrations of salinity and organic

carbon in those waters, could be better matched to domestic, agricultural, and environmental uses. Alternatively, the timing and location of urban and agricultural discharges to the Delta and other water sources could also be coordinated with the eventual use of potentially impacted diversions.

- The state should encourage upstream users to treat wastewater to the highest level possible to facilitate re-use downstream.

Pollution prevention

Pollution prevention can improve water quality for all beneficial uses by protecting water at its source, reducing the need and cost for other water management and treatment options. By preventing pollution throughout a watershed, water supplies can be used, and re-used, for a broader number and types of downstream water uses. Improving water quality by protecting source water is consistent with a watershed management approach to water resources problems.

Current status

There are many tools — regulatory, voluntary, or incentive-based — available for preventing pollution. The U.S. Environmental Protection Agency, California Environmental Protection Agency, State Water Resources Control Board, and Regional Water Quality Control Boards have permitting, enforcement, remediation, monitoring, and watershed-based programs to prevent both point source (i.e. from pipes) and non-point source pollution. Preventing pollution from most point sources relies upon a combination of source control and treatment, while preventing non-point source pollution generally utilizes best management practices (BMPs). The SWRCB and RWQCBs are implementing total maximum daily loads (or TMDLs) to control both point and non-point source pollution in those water bodies that are not attaining their water quality standards. The SWRCB and RWQCBs are also focusing on water quality issues related to abandoned mines, the U.S. - Mexico border, and beach closures. U.S. EPA and the state Department of Health Services have sanitary survey and source water assessment programs specifically for drinking water sources. Beyond these state and federal efforts, many local agencies, businesses, non-governmental organizations, and watershed-based groups are preventing pollution directly, on their own or through partnerships.

Surface water quality

The state's official evaluation of its surface water quality is the SWRCB's biennial water quality assessment, which in 2002 listed 679 "water quality limited segments" in California (a segment being some portion of a water body like a river or lake). These are water bodies that do not meet their established water quality standards, most often for metals or pesticides. As of 2000, fish consumption advisories, an indirect indicator of surface water quality, were posted for 18 percent of California's lakes,

Sources

- 2002 California 305(b) Report on Water Quality, *State Water Resources Control Board, March 2003*
- *Bulletin 118 (Draft),* California's Groundwater, Update 2003, *Department of Water Resources*
- A Comprehensive Groundwater Quality Monitoring Program for California *(AB 599 Report to the Governor and Legislature), State Water Resources Control Board, March 1, 2003*
- *National Water-Quality Assessment Program, US Geological Survey*
- *State Water Resources Control Board/ Regional Water Quality Control Boards, Strategic Plan, November 15, 2001*
- *Water Quality Program Plan, CALFED Bay Delta Program, July 2000*
- *The San Joaquin Valley Drainage Implementation Program Gap Analysis, October 2002.*
- *California Coastal Commission, www.coastal.ca.gov*
- *U.S. EPA National Water Quality Inventory*
- *DHS data website: http://www.dhs.ca.gov/ps/ddwem/chemicals/chemindex.htm*

Please note

Refer to Chapter 2 for a more detailed discussion of the legal and regulatory framework for protecting ambient water quality.

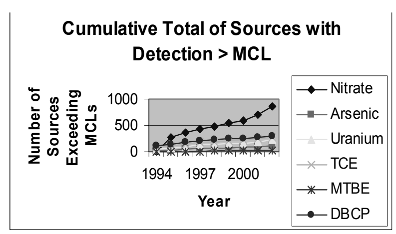


Figure X Cumulative total of sources with detection > MCL

while less than 1 percent of the state's rivers were similarly posted.

Groundwater quality

Please note

The DHS database, though, only covered wells in about half of the groundwater basins in the state. And even for those basins that have wells in the database, the water quality in those wells is not necessarily representative of the water quality throughout the basin.

Although standards or objectives do not cover all water quality contaminants (for example, perchlorate), the majority of wells (62 percent) reviewed by DWR's Bulletin 118 (*California's Groundwater*), using data provided by DHS, met Title 22 maximum contaminant levels (MCLs) for the period of 1994-2000. However, in each of the state's hydrological regions, a large percentage of public water supply wells (ranging from 24 percent to 49 percent) exceeded one or more MCLs, usually for inorganic chemicals or radioactivity. Statewide, nitrate, which presents a known, acute (i.e. short-term) health risk, has closed more public water wells than any other contaminant, as a result of man-made contamination from agricultural practices and septic tanks. Other common groundwater contaminants of concern, including arsenic, perchlorate, and hexavalent chromium, are chronic (or long-term) health risks, such as cancer and reproductive and endocrine system dysfunction. Another common groundwater contaminant, salinity, while not a health risk, is a concern for water palatability as well as economics. A different indicator of groundwater quality, leaking underground fuel tanks, has steadily declined after peaking in 1995, due primarily to the success of regulatory action.

Environmental water quality

Throughout California, water quality impairments threaten riparian and aquatic habitats, and in some cases are major impediments to ecosystem restoration. Urban, military, industry, hydropower, mining, logging, agriculture, grazing, and recreational activities impact water quality. Depleted freshwater flows, due to upstream dams, diversions, and inter-basin transfers, also affect the quality of water downstream. Other water management actions and projects, such as conjunctive use, conveyance, transfers, and conservation, can also affect water quality, both positively and negatively. Many significant pollution problems today are the result of persistent "legacy" pollutants, such as mercury (extracted from the Coast Range and used to process gold in the Sierra mines in the 19^{th} century), and industrial chemicals such as polychlorinated biphenyls (PCBs), used in electrical transformers. These pollutants also contaminate sediments, making ecosystem restoration efforts more difficult. Hydraulic mining, which ceased during the 19^{th} century, still has an adverse impact on numerous Central Valley rivers. Some environmental contaminants of concern, such as mercury and selenium, are persistent and/or bioaccumulative—that is, their concentration and toxicity magnifies in the food chain—and can be toxic to key food chain links, such as aquatic invertebrates, and negatively impact communities and tribes dependent upon subsistence fisheries.

Drinking water sources

Public water systems in California have approximately 15,000 groundwater sources and 1,000 surface water sources of drinking water. About 4,000 (or one quarter) of these sources have at least one detection of a regulated contaminant, mostly from man-made sources, at a level greater than its MCL. The data specifically show a steady increase in the number of wells that exceed MCLs for nitrate and arsenic; moreover, the MCL for arsenic, a naturally-occurring contaminant, will drop even further in 2006, affecting another 900 drinking water sources. Uranium, a radionuclide, and the organic chemicals trichloroethylene (TCE), dibromochloropropane (DBCP) and methyl tertiary-butyl ether (MTBE), also frequently pollute drinking water sources. In the near future, California will promulgate new MCLs for perchlorate and chromium-6, in addition to the one for arsenic.

DHS, with the assistance of 34 counties and 500 water systems, recently completed source water assessments for 15,000 public drinking water sources in California. Initial evaluation of the assessment results indicates that groundwater sources (approximately 14,000 wells) are most vulnerable to on-site sewage disposal (septic) systems and sewer collection systems. Surface water sources are most vulnerable to surface water recreation and septic systems. These assessments, combined with water quality monitoring, suggest that California is not doing enough to prevent nitrate pollution, an acute health hazard to infants, the MCL for which has the lowest margin of safety of all regulated drinking water contaminants.

One particular drinking water source, the Sacramento-San Joaquin Delta, provides some portion of the water supply for more than 22 million Californians. A unique aspect of this water source is that seawater introduces relatively high levels of bromide that, upon ozonation in a domestic water treatment plant, can be converted to bromate, a potential carcinogen.

Potential benefits

For the vast majority of contaminants, it is generally accepted that a pollution prevention approach to water quality is more cost-effective than end-of-the-pipe treatment of wastes, or advanced domestic water treatment for drinking water. Pollution prevention measures are usually more cost-effective because they have lower initial capital costs, as well as less ongoing operations and maintenance costs, than traditional engineered treatment systems. However, because of the nature and sources of some contaminants, like bromide (introduced by seawater) and organic carbon (natural runoff from the watershed), a pollution prevention approach may not be possible, cost-effective, or even desirable.

Pollution prevention can not only avoid economic costs, but also yield economic benefits. As one example, a 1998 Public Research Institute study estimated that California beaches, which are often closed because of contamination from urban runoff, stormwater, and sanitary sewer overflows, contributed $73 billion to the US economy, creating 883,000 jobs. Near-shore coastal waters provide multiple benefits or uses by also serving as a water source for desalination plants, as well as habitat for wildlife.

Potential costs

According to a 2000 U.S. EPA Clean Water Needs Survey, California has more than $14 billion of needs to prevent both point source and non-point source pollution. This survey, though, emphasized point source discharges (which represented over $13 billion of the needs), and likely underestimated the cost of measures to adequately prevent non-point source pollution.

Major issues

Urban impacts – USEPA's most recent National Water Quality Inventory (in 2001) found that nonpoint source pollution from urban and agricultural runoff are the primary sources of water pollution in the U.S. Urban runoff and stormwater wash pollutants, such as nutrients (lawn fertilizers and pet wastes), pesticides, oil and grease, metals, organic chemicals, microorganisms, and debris, from city streets and other hard surfaces, that impair surface waters, including beaches ,and negatively impact existing and future groundwater replenishment projects that use stormwater for recharge.

Agricultural impacts –Agricultural drainage can impair water supplies with relatively high levels of salinity, nutrients, pesticides, and other contaminants, as can wastes from dairies and feedlots, which are high in nitrates and microbes. In the Central Valley, the Regional Water Quality

Please note

For a fuller discussion, refer to the Urban Runoff and Watershed Management narratives.

Control Board has endorsed the use of farm-based watershed groups to monitor water quality and implement best management practices (BMPs) to control nonpoint source pollution from seven million acres of irrigated lands (i.e. crops, nurseries, and managed wetlands).

Natural impacts – Relative to contamination introduced primarily by humans, organic carbon, derived from runoff from a watershed, and especially bromide, a component of ocean salinity, are largely a result of natural processes for which a pollution prevention approach may not be completely effective or appropriate. Further, organic carbon is beneficial to the ecosystem in general, and when combined with some advanced treatment options, both organic carbon and bromide can be less onerous in treated water. While not ignoring pollution prevention opportunities (especially for organic carbon), the use and integration of other water quality management tools, such as matching water quality to use and drinking water treatment and distribution, may be more effective and appropriate for these two contaminants.

Emerging contaminants – Currently water agencies focus on pathogens (disease –causing microorganisms) and disinfectant by-products (potential cancer-causing contaminants), that are regulated or will be regulated in near future. Recently, though, unregulated chemicals found in pharmaceuticals and personal care products are emerging as water contaminants that may not be removed by traditional treatment processes, and can negatively impact recycling and groundwater recharge projects.

Population growth demands and impacts — Future population growth and land-use changes may unpredictably affect water quality. As population and water demand increase, the volume of wastewater will also increase, which may then be discharged in proportions to the receiving water flow that could prevent some current domestic water sources to continue serving that beneficial use. Moreover, as demand for water grows, there may be demand as well to use some supplies, such as those originating from groundwater remediation sites, which would previously not have been approved for domestic use. For such supplies, drinking water standards alone may not be enough to determine quality, because such standards assume a basic purity of the water supply.

Monitoring and assessment –Only a small portion of California water bodies are regularly monitored and assessed for water quality or even for the appropriate contaminants of concern Once data is collected, it is too often not assessed or evaluated, and therefore not readily available for analysis. Much water quality data is collected on a project, rather than comprehensive, basis. Even the SWRCB's biennial water quality assessment is limited by data availability, and notes as well another data dilemma: “healthy environments are less likely than troubled ones to be targeted for monitoring.”

Fragmented delivery and regulation of water quality – Management and regulation of water quality in California is currently fragmented among at least eight State and federal agencies, with no one agency looking after water quality “from source to tap.” For example, the state and Regional Boards regulate source water quality, and DHS primarily regulates treatment and distribution of potable water. Further, surface water in California is mostly managed by DWR and the U.S. Bureau of Reclamation, while groundwater is mostly not managed at all. Moreover, actually serving drinking water to Californians is an obligation of local agencies (cities and water districts) and private water companies that were generally not formed in any comprehensive pattern.

Pollutant-by-pollutant water quality management – Federal law requires that the state regulate water quality on a programmatic, pollutant-by-pollutant basis, even though our rivers, lakes, and bays — and the aquatic organisms in them—are actually exposed to a mix of pollutants. Much has yet to be understood about the combined effects of chemicals, temperature, pH, transport, sunlight, and other factors. From the standpoint of ecosystem integrity, it is important to recognize that major threats may not be observed in obvious fish kills, but instead may arise subtly through sub-lethal changes in reproductive rates, gene structure, nervous system functions, or immune response. Such changes can over time affect species survival, and population and ecosystem structure.

Recommendations

- In addition to regulating water quality on a pollutant-by-pollutant basis, water quality problems can be best managed using a watershed-based “source-to-tap” approach. The state should adopt a preventative strategy that integrates improvements in pollution prevention, water quality matching, and, for drinking water, treatment and distribution. For pollution prevention, such a strategy would build upon urban and agricultural nonpoint source pollution prevention programs already initiated by the SWRCB and RWQCBs, as well as DHS’s Source Water Assessment Program. The program would focus in particular on prevention of nitrate pollution statewide.
- In order to help implement the previous recommendation, the state

Please note

Such a strategy would be much like the “Equivalent Level of Public Health Protection (ELPH)” process of the CALFED Drinking Water Quality Program, and similar efforts recently established by the Massachusetts Water Resources Authority (for Boston), New York City, and the national governments of Canada and Australia. This strategy would also conform to the recommendations of the 2000 International Conference on Freshwater, held in Bonn, Germany.

should adequately fund basin plan triennial review and updates, for incorporation into the *California Water Plan Update* (pursuant to Section 13141 of the California Water Code). Per the CALFED Record of Decision, the state should complete the Delta Drinking Water Policy for the Delta and its tributaries, which as an amendment to the basin plan for the Sacramento and San Joaquin river basins, may be an additional tool for drinking water source protection.

- State agencies with a regulatory, management, or scientific role in the California's water quality should establish an Interagency Water Quality Program to coordinate and integrate all federal, state, and local water quality monitoring and assessment programs, for surface water and groundwater. This program would include a focus on emerging, unregulated contaminants in order to provide an early warning system of future water quality problems, as well as identify trends in water quality. Such a program would also seek to standardize methods for monitoring of emerging, unregulated contaminants, regularly monitor the quality of all waters of the state, and provide necessary data management.
- Regional, tribal, and local governments and agencies should establish drinking water source protection programs to shield drinking water sources from contamination, which should then be incorporated into local land use plans and policies. Such programs would encourage or regulate land-use activities that are protective of water quality, or, alternatively, discourage or restrict land uses or activities that threaten surface and groundwater quality.
- The state should provide increased grant funding for source water protection activities.

Please note

The groundwater portion of this effort should be consistent with the recommendations of AB 599 (the Groundwater Quality Monitoring Act of 2001), while the surface water aspects should be coordinated with SWRCB's Surface Water Ambient Monitoring Program (SWAMP).

Precipitation enhancement

Precipitation enhancement is when clouds are artificially stimulated by cloud seeding to produce more rain or snow than they would naturally. Cloud seeding injects special substances into the clouds that enable snowflakes and raindrops to form more easily. Precipitation enhancement is the one form of weather modification conducted in California; hail suppression and fog dispersal (when fog is below freezing temperature) projects are conducted in other states.

Precipitation enhancement in California

The first serious cloud seeding program in California began in 1948 on Bishop Creek in the Owens River basin for California Electric Power Company. Precipitation enhancement in the form of cloud seeding has been practiced continuously in several California river basins since the early 1950s. Most projects are located along the central and southern Sierra Nevada with some in the coast ranges. The projects use silver iodide as the active cloud seeding agent, supplemented by dry ice if aerial seeding is done. The silver iodide can be applied from ground generators or from airplanes. Occasionally other agents, such as liquid propane, have been used. In recent years, some projects have also been applying hygroscopic materials (substances which take up water from the air) as supplemental seeding agents.

Operators engaged in cloud seeding have found it beneficial to seed rain bands along the coast and orographic clouds over the mountains. The number of operating projects has tended to increase during droughts, up to 20 in 1991, but have leveled off to about 12 annually in recent years. The area covered by these projects is about 13,000 square miles.

Policy statements by both the American Meteorological Society and the World Meteorological Organization support the effectiveness of winter orographic cloud seeding. The American Society of Civil Engineers has also shown interest and is developing its “Standard Practice for the Design and Operation of Precipitation Enhancement Projects” to be completed in 2004. (A draft edition is currently available from ASCE.) This standards document will be a sequel to ASCE Manual No. 81, “Guidelines for Cloud Seeding to Augment Precipitation,” published in 1995.

Precipitation enhancement benefits

In California, all precipitation enhancement projects are intended to increase water supply or hydroelectric power generation. The amounts of

Information sources

- *ASCE Manual No. 81 “Guidelines for Cloud Seeding to Augment Precipitation” (1995)*
- *ASCE “Standard Practice for the Design and Operation of Precipitation Enhancement Projects”, production in progress to be completed by early 2004.*
- *National Oceanic and Atmospheric Administration*
- *Desert Research Institute, Reno, Nevada*
- *American Meteorological Society*
- *World Meteorological Organization*
- *USBR Project Skywater publications, various, 1975-1987, including those of the Sierra Cooperative Pilot Project in California.*
- *Sierra Cooperative Pilot Project, Environmental Assessment and Finding of no Significant Impact, USBR, Denver, 1981.*

(Suggested: a map figure showing location of rain and snow enhancement projects in California in 2000 or maybe 2003?)

water produced are difficult to determine, but estimates range from a 2 to 15 percent increase in annual precipitation or runoff. A detailed study by the Utah Department of Natural Resources in 2000 showed an average increase in April 1 snowpack water content ranging from 7 to 20 percent from a group of projects which had been operating from nine to 22 years. The overall estimated annual runoff increase was about 250,000 acre-feet, or 13 percent for the study area. Actual increases in annual runoff are probably significantly less in California than in Utah. One conservative estimate is that the combined California precipitation enhancement projects currently generate 300,000 to 400,000 acre-feet annually, which would be an average of about a 4 percent increase for all projects.

Another 300,000 to 400,000 acre-feet per year may be available. Many of the best prospects are in the northern portion of the state. Most of the potential new yield is in the Sacramento River basin, in catchments that are not seeded now. The Lahontan regions are already well covered by cloud seeding projects, except for the Susan River. With the exception of the Trinity River watershed, there is little new potential in the North Coast region because not much extra rainfall could be utilized due to limited storage capacity.

Precipitation enhancement should not be viewed as a remedy for drought. Cloud seeding opportunities are generally less in dry years. It works better in combination with surface or ground water storage to increase average supplies. In the very wet years, when sponsors already have enough water, cloud seeding operations are usually suspended.

Potential costs

Costs for cloud seeding generally would be less than $20 per acre-foot per year. State law says that water gained from cloud seeding is treated the same as natural supply in regard to water rights.

It is estimated that about $3 million is being spent on current operations. Realizing the additional 300,000 to 400,000 acre-feet of potential new supply could require $4 million to $5 million, which would be about $12 per acre-foot. An initial investment of an estimated $1.5 million to $2 million in planning and environmental studies would also be required.

Precipitation enhancement issues

The major issues facing the use of precipitation enhancement practices are:

Reliable data – Some studies of individual projects have been made in the past years on certain projects, such as the Kings River, which have shown increases in water, albeit with statistical questions. No complete and rigorous comprehensive study has been made of all California precipitation enhancement projects. Part of the reason is the difficulty in locating unaffected control basins for the standard target and nearby control area comparisons since wind variations would cause spillover into adjoining basins.

Operational precision – It is difficult to target seeding materials to the right place in the clouds at the right time. There is an incomplete understanding of how effective operators are in their targeting practices. Chemical tracer experiments have been done and provide support for current targeting ideas.

Concern over potential impacts – Questions about potential unintended impacts from precipitation enhancement have been raised and addressed over the years. Common concerns relate to downwind effects (enhancing precipitation in one area at the expense of those downwind), long term toxic effects of silver, and added snow removal costs in mountain counties. The U.S. Bureau of Reclamation did extensive studies on these issues. The findings are reported in its Project Skywater programmatic environmental statement in 1977 and in its Sierra Cooperative Pilot Project EIS in 1981. The available evidence does not show that seeding clouds with silver iodide causes a decrease in downwind precipitation; in fact, at times some of the increase of the target area may extend up to 100 miles downwind. The potential for eventual toxic effects of silver has not been shown to be a problem. Silver and silver compounds have a rather low order of both acute and chronic toxicity. According to the Bureau of Reclamation, the small amounts used in cloud seeding do not compare to industry emissions of 100 times as much into the atmosphere in many parts of the country or individual exposure from tooth fillings. Watershed concentrations would be extremely low because only small amounts of seeding agent are used. Accumulations in the soil, vegetation and surface runoff have not been large enough to measure above natural background. In regard to snow removal, little direct relationship to increased costs was found for small incremental changes in storm size because the amount of equipment and manpower to maintain the roadway is essentially unchanged. For example, the effort is practically the same to clear 5.5 inches compared to 5 inches of snow on the road.

All operating projects have suspension criteria designed to stop cloud seeding any time there is flood threat. Moreover, the kind of storms which produce large floods are naturally quite efficient in processing moisture into rain anyway. In such conditions, seeding is unlikely to make much difference.

Concern about continuance of hydroelectric utility seeding operations—Four of the existing cloud seeding projects in California are sponsored by hydroelectric utilities. These four projects probably account for about 1/3 of the estimated statewide water production by cloud seeding. There is some fear that if these power plant facilities are sold, either as part of deregulation or for other reasons, potential new owners may not be interested in continuing cloud seeding. This would result in some loss in water supply for downstream users who have been indirectly benefiting from the added water. The State Public Utilities Commission is aware of this possibility and has tried to ensure, as a condition of transfer, that weather modification would continue.

Recommendations

- Collect base data and perform research on the effectiveness of California precipitation enhancement and how it could supplement other water supplies while minimizing negative impacts.
- Support the continuation of current projects as well as the addition of new projects. Create a new Department of Water Resources program to investigate potential new cloud seeding projects.
- Investigate the potential to augment Colorado River supply by cloud seeding, in cooperation with the Colorado River Board, the states of Arizona and Nevada, and the U.S. Bureau of Reclamation.
- Keep abreast of current research on cloud physics and cloud modeling being done by the National Oceanic and Atmospheric Association (NOAA) labs and academic institutions. With improvement, these models may become tools to further verify and test the effectiveness of cloud seeding activities.
- Support efforts by California weather modification project sponsors, such as a 2002-03 proposal by Santa Barbara County Water Agency to obtain federal research funds.

Recharge areas

Recharge areas are those areas that provide the primary means of replenishing the groundwater that is stored in an aquifer. Protection of recharge areas, whether natural or man-made, is necessary if the quantity and quality of groundwater in the aquifer are to be maintained. Recharge areas must be protected so that they remain functional and they are not contaminated with chemical or microbial constituents.

Current status

Beginning in the early 1900s, recharge areas were operated by water agencies in San Joaquin Valley. Recharge areas along the east side of San Joaquin Valley were established in the 1940s. Additional recharge areas were established later in southern California and San Francisco Bay area. The size of existing recharge areas and the amount of groundwater that is recharged annually is substantial. The total amount of land devoted to spreading basins, or off-stream or in-stream recharge probably exceeds 50 square miles. The actual area is difficult to determine partially because many diversion ditches and creeks are active recharge sites certain periods of time.

Potential benefits from protection of recharge areas

The potential amount of recharge that might occur is determined by:

- Availability of water to use for recharge
- Recharge facilities available to receive and percolate the water
- Amount of empty storage capacity in the aquifer

The benefits of recharging groundwater include some microbial and chemical degradation while the water moves through the unsaturated zone to the saturated zone, an increase in the amount of groundwater in storage that can later be extracted for local use or for export, and in some cases, use of the aquifer itself as the conveyance system for the point of extraction and use.

In some cities, recharge basins are combined with flood control basins to reduce the amount of urban runoff.

Potential costs of not protecting recharge areas

Sources

- *Biennial Groundwater Conference and Annual Meeting of the Groundwater Resources Association of California Abstracts, 2001, Water Resources Center, University of California.*
- *California Department of Health Services,* California's Drinking Water Source Assessment and Protection (DWSAP) Program: Guidance and Other Information, *updated 27 May 2003. Available at: http://www.dhs.cahwnet.gov/ps/ddwem/dwsap/DWSAPindex.htm*
- *Driscoll, Fletcher G., Ph.D., 1986,* Groundwater and Wells, *Johnson Division, St. Paul, Minnesota.*
- *Dunne, Thomas, and Leopold, Luna B., 1978,* Water in Environmental Planning, *W.H. Freeman and Company, San Francisco.*
- *Fetter, C.W., 1994,* Applied Hydrogeology, *Prentice-Hall.*
- *Freeze, R.A., and Cherry, J.A., 1979,* Groundwater, *Prentice-Hall, Inc., New Jersey.*
- *Sherman, Leroy K., and Musgrave, George W., 1942,* Infiltration, *in* Hydrology, *edited by Oscar E. Meinzer, Dover Publications, Inc., New York.*
- *U.S. Geological Survey, 2002,* Artificial Recharge Workshop Proceedings, Sacramento, California, April 2-4, 2002, *Open-File Report 02-89.*
- *U.S. Geological Survey, 2002,* Ground Water and Surface Water, A Single Resource, *U.S.G.S. Circular 1139,*
- *U.S. Geological Survey, 2002,* Assessing Ground-Water Vulnerability

The potential costs of not protecting recharge areas can be considerable. Protection consists of two components:

- preventing the areas from being covered by urban infrastructure, which renders the land unusable for recharge
- preventing chemical or microbial contamination that would require expensive treatment before the water could be used for potable purposes.

First, the growth of urban areas, with roads, freeways, parking lots, and large warehouse type buildings, means that many areas no longer allow runoff to infiltrate into the ground. Instead, the runoff flows rapidly into streams which reach a peak flow more quickly that is higher than before the urban facilities were built. This runoff is lost to groundwater recharge and may require the expense of other facilities to provide that lost recharge. Or that potential recharge may just be lost to the aquifer. In some urban areas injection wells have been built to take the place of recharge that has been prevented by the urban facilities. Injection wells are expensive and are not always successful, but they may be cost effective in the face of the high cost of urban land in many cities.

TreePeople, a citizens' organization, has been working with local government to retrofit play grounds, school grounds, parking lots, and other parcels of land, to collect, treat, and funnel storm water to "dry" wells or other small scale infiltration facilities. Such wells are called Class V injection wells and to avoid contamination of the aquifer certain management practices are recommended. Those best management practices include low-flow basins for run-off from industrial areas and other areas that could provide a high level of chemical contamination, pre-treatment for such run-off, monitoring of water quality, evaluation of the data, and corrective action as necessary.

Second, many potentially contaminating activities have routinely been allowed in recharge areas, leading to the presence of those contaminants in the recharge area. In many basins and subbasins, the recharge areas were contaminated and groundwater obtained from those aquifers now requires remediation. Remediation is a process that takes decades, costs large amounts of money, and will never remove the contaminant completely from the aquifer.

A lack of protection of recharge areas could decrease the availability of groundwater. Recent studies by the USGS show contaminants present in recharge areas for aquifers in the Los Angeles area. In 10, 20, or 40 years, those contaminants will have been transported into the aquifer and may require treatment before the groundwater can be used, which will increase the cost of water.

However, protection of recharge areas now will help to prevent those costs from escalating astronomically in the future. Because of the low velocity of groundwater movement through the aquifer, contamination that occurs today will not arrive at down-gradient wells for 10 years or longer. If we protect recharge areas by retaining those areas for recharge and by preventing contamination today, we are reducing future costs.

Major issues

Water Quality – Land uses in recharge areas should be regulated in a manner that eliminates the possibility of contaminants entering the subsurface. Pre-treatment may also be required before the water can be recharged. The Department of Health Services has published draft regulations regarding recharging recycled water. Monitoring wells should be installed to provide information on changes that may be caused by recharge.

Water Quantity – Land uses in recharge areas should be restricted so that those high infiltration rate areas can continue to be used to recharge the aquifer.

Local Government and Land Use – Local governments should identify potential recharge areas in the County and City general plans and discuss what measures are being taken to protect those areas from development that would render them useless or would contaminate them.

Vector and Odor Issues – Standing water in recharge ponds or spreading basins is a magnet for mosquitos (Diptera), dragonflies (Odonata), and other insects whose egg, larval, and pupal stages mature underwater. Dragonflies eat insects they catch on the fly, but mosquitos can be vectors for a number of serious or deadly diseases. Existing recharge programs use large numbers of “mosquito” fish which feed on the mosquito larvae in the water. Odors can be generated by growth and decay of algae and other water-borne vegetation. Both vectors and odors must be addressed in any recharge program that involves standing water.

Potential Impacts – Protection of recharge areas will ensure that replenishment of aquifers with good quality water will continue to take place, ensuring a sustainable and usable water supply. Lack of protection of recharge areas will decrease the quantity of groundwater that is available and will allow contamination of the groundwater in the aquifer. Such contamination will require that the water extracted by wells will require treatment at the wellhead before it can be used as a potable supply.

Recommendations

- The state can help promote additional protection of recharge areas by acting on the following recommendations:
- Increase state funding for proposals to protect recharge areas.
- Expand funding sources to include sustainable state funding for research into surface spreading as a means of groundwater recharge and the fate of chemicals and microbes contained in the recharge water.
- Expand funding sources to include a statewide program to identify potential recharge areas throughout the state and provide that information to local land use agencies (city and county governments).
- Engage the public in an active dialogue using a value-based decision-making model in planning land use decisions that involve recharge areas.
- Establish a water element in general plans that specifically require a discussion by local government of the values of protecting recharge areas versus non-protection.
- Require local governments to provide protection of recharge areas for aquifers that have been identified as “sole source aquifers” pursuant to the Safe Drinking Water Act of 1974 (P.L. 93-523) and Amendments.
- Require that source water protection plans include an element that addresses recharge areas if groundwater is a part of the supply.
- Convene a statewide panel to recommend changes to public schools and higher education curricula relating to groundwater.
- Encourage an integrated academic program on one or more campuses for protection of groundwater quantity and quality and why recharge areas are critical components.
- Develop a uniform method for analyzing the economic benefits and cost of recharge areas and provide guidance and assistance for economic feasibility analyses that could be used by project planners and funding agencies to assess recharge areas vis-a-vis long-term loss of water supplies, wellhead treatment, or injection wells.
- Adopt a state-sponsored media campaign to increase public awareness and knowledge of groundwater and the importance of recharge areas.

Recycled municipal water

Recycled municipal water is municipal wastewater that has been treated for additional beneficial use. The treatment and use of municipal wastewater for golf course irrigation is an example of recycled water. Higher levels of treatment beyond disinfected tertiary recycled water can make municipal wastewater reusable for school yard, residential landscape and park irrigation, industrial uses or even uses within office and institutional buildings.

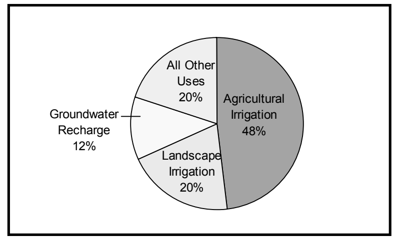


Figure X Where recycled water is used in California

Current recycled water in California

Californians have used recycled water since the late 1800s and public health protections have been in effect since the early part of the 1900s. Recycled water use has dramatically increased in the past several decades as water agencies needed to supplement their water supplies. Today, California's water agencies recycle about 500,000 acre-feet of wastewater annually, almost three times more than in 1970.

Potential benefits from recycled water

There is a potential of about 1.5 million acre-feet of additional recycled water by the year 2030. Of that amount, about 1.2 million acre-feet would be new water supply. When compared to the household use of the additional 17 million Californians projected by 2030, this new water could substitute for enough fresh water to meet the household water demands of 30 to 50 percent of the household water demand.

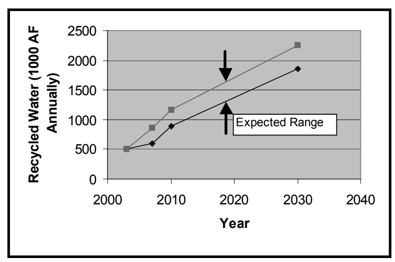


Figure X Range of potential water recycling

The primary benefit of recycled water is augmenting water supply. Rather than discharging and losing the water, recycled water can be reused as a new water supply. Using recycled water for irrigation can spare high quality potable water currently used for irrigation, making more potable water supply available.

Recycling in some areas may provide new water for the water agency, but not the state. Discharged wastewater in interior California mixes with other water and becomes source water for downstream water users. Only areas such as coastal areas or areas discharging to an unusable salt sink add new water supply by recycling wastewater.

Local benefits

For many communities, an investment in recycled water could provide other benefits:

1. *Provide additional reliable local sources of water, nutrients, and organic matter for agricultural soil conditioning and reduction in fertilizer use*
2. *Reduce the discharge of pollutants to water bodies, beyond levels prescribed by regulations, and allow more natural treatment by land application*
3. *Provide a more secure water supply during drought periods.*
4. *Provide economic benefits resulting from a more secure water supply.*

Potential costs of recycled water

The estimated capital cost for 1.5 million acre-feet of additional recycled water is about $11 billion. The actual cost will depend on the quality of the wastewater and the treatment level to meet recycled water intended use. Uses such as irrigation near the treatment facility will benefit from lower treatment and distribution costs. Irrigation can even benefit from the nutrients in the recycled water by lowering the need for applied fertilizers. Some uses, such as industrial process located farther away from the treatment facility, may need to pay higher costs for treatment and distribution. Given the wide range of local conditions that can affect costs, the majority of applications would cost between $300 and $1,300 per acre-foot of recycled water. Costs outside this range may be feasible depending on local conditions. Uses that require higher water quality and have higher public health concerns will have higher costs.

Major issues facing more recycled water use

The major issues facing additional recycled water use are:

Affordability – The cost of recycled water, relative to other water sources, will influence how much recycled water is produced for each region. The costs are dependent on the availability of treatable water, demand for treatable water, the quality of the water, the type of beneficial use, and proximity of recycled water facilities to the water users. The lack of adequate local funding to plan feasible recycled water projects can slow new projects. Public funding of incentive and disincentive measures can help advance projects that provide benefits to the state. The cost of recycled water can influence water markets, especially if recycled water is available for transfer.

Water Quality – The quality of the recycled water will affect its uses. Public acceptance of recycled water use is dependent on confidence in the safety of its use. Four water quality factors are of particular concern: (1) microbiological quality, (2) salinity, (3) presence of toxicant of the heavy metal type, and (4) the concentration of stable organic and inorganic substances. For example, the salinity of recycled water can limit its usefulness for some applications such as salt sensitive landscaping, golf courses, and agriculture. Each use of water generally adds salt to the water. For example, the use of water softeners adds salt to the water. Water conservation can further concentrate salts. Water that is high in salts is more difficult, and expensive to recycle so there is generally a limit to how many times water can be recycled unless more expensive treatment technology can be used at added cost to remove the salts, such as reverse osmosis.

Public Acceptance – Public perception and acceptance of some recycled water uses currently limits its application. In some areas, public concerns about potential health issues have limited recycled water for indirect potable reuse.

Potential Impacts – Areas in interior California that currently discharge their wastewater to streams, rivers, or the groundwater contribute to downstream flows. Recycling water would remove this source of water and potentially affect downstream water users including the environment. In some instances, recycling is discouraged when dischargers are required to maintain a certain flow in the stream for downstream users.

Recommendations

Funding for water recycling

- State funding for water reuse/recycling facilities and infrastructure should be increased beyond Proposition 50 and other current sources.
- The state should expand funding sources to include sustainable state funding for research on recycled water issues.
- The state should encourage an integrated academic program on one or more campuses for water reuse research and education.
- Funding sources should be expanded to include sustainable state funding for the Department of Water Resources' technical assistance and research, including flexibility to work on local and regional planning, emerging issues, and new technology.
- A revised funding procedure should be developed to provide local agencies with assistance in potential state and federal funding opportunities.
- Resources should be provided to funding agencies to perform comprehensive analysis of the performance of existing recycled water projects in terms of costs and benefits and recycled water deliveries. An estimate should be performed of future benefits potentially resulting from future investments.
- A uniform and economically valid procedural framework should be developed to determine the economic benefits and costs of water recycling projects for use by local, state, and federal agencies.

Guidance should be developed to conduct economic feasibility analyses, incorporating nonmarket values to the extent possible. Appropriate benchmarks for comparing incremental costs of developing recycled water with the cost of developing an equivalent amount through alternative measures. An advisory team should be created by the Department of Water Resources, the State Water Resources Control Board, and the Department of Health Services to assist these tasks.

- Local agencies are encouraged to perform economic analyses in addition to financial analyses for water recycling projects to provide transparency regarding the true costs and benefits of projects. State and federal agencies should require economic and financial feasibility as two funding criteria in their funding programs.
- State and local tax incentives should be provided to recycled water users to help offset the permitting and reporting costs associated with the use of recycled water.
- State funding agencies should make better use of existing regional planning studies to determine the funding priority of projects. This process would not exclude projects from funding where regional plans do not exist.
- Funding agencies should publicize funding availability through workshops, conferences, and the Internet.

Community value-based decision-making model for project planning

- Local agencies should engage the public in an active dialogue and participation using a community value-based decision-making model in planning water recycling projects. Public participation activities should go beyond the minimum requirements of state and federal environmental laws, perhaps being reinforced by state funding agencies requiring a comprehensive public participation process as a condition for receiving state funds.

Leadership support for water recycling

- State government should take a leadership role in encouraging recycled water use and improve consistency of policy within branches of state government. Local agencies should create well-defined recycled water ordinances. Local regulatory agencies should effectively enforce these ordinances. The state should convene an independent statewide review panel on indirect potable reuse to ensure adequate health and safety assurance for California residents.

- Help local and regional agencies comply with the water recycling provisions in the Urban Water Management Planning Act.
- Appropriate local agencies should adopt well-defined local water recycling ordinances.
- Building inspectors, code enforcement offices, etc., should effectively enforce the installation of type of plumbing that would allow the use of recycled water in accordance with local recycled water ordinances.

Education

- The state should develop comprehensive education curricula for public schools; and institutions of higher education should incorporate recycled water education into their curricula. Governmental and nongovernmental organizations should enhance their existing public education programs.

State-sponsored media campaign

- The state should develop a water issues information program, including water recycling, for radio, television, print, and other media.

Permitting/plumbing code/cross-connection control

- Uniform Plumbing Code Appendix J – The state should revise Appendix J of the Uniform Plumbing Code, which addresses plumbing within buildings with both potable and recycled water systems, and adopt a California version that will be enforceable in this state.
- DHS Guidance on Cross-connection Control – The Department of Health Services should prepare guidance that would clarify the intent and applicability of Title 22, Article 5 of the California Code of Regulations pertaining to dual plumbed systems and amend this article to be consistent with requirements included in a California

version of Appendix J that the Task Force is recommending to be adopted.

- Health and Safety Regulation – The Department of Health Services should involve stakeholders in a review of various factors to identify any needs for enhancing existing local and state health regulation associated with the use of recycled water.
- Recycled Water Symbol Code Change – The Department of Housing and Community Development should submit a code change to remove the requirement for the skull and crossbones symbol in Sections 601.2.2 and 601.2.3 of the California Plumbing Code.
- Cross-connection Risk Assessment – The Department of Health Services should support a thorough assessment of the risk associated with cross-connections between disinfected tertiary recycled water and potable water.
- Permitting Procedures – Various measures should be conducted to improve the administration of and compliance with local and state permits, including providing Department of Health Services guidance, dissemination of information by the Association of California Water Agencies and the California Association of Sanitation Agencies, and state and local tax incentives to offset costs of compliance with regulations.
- Stakeholder Review of Proposed Cross-connection Control Regulations – Stakeholders are encouraged to review Department of Health Services' draft changes to Title 17 of the Code of Regulations pertaining to cross-connections between potable and nonpotable water systems.

UNIFORM INTERPRETATION OF STATE STANDARDS

- The state should create uniform interpretation of state standards in state and local regulatory programs by taking specific steps recommended by the Task Force, for example, appointing an ombudsman in the State Water Resources Control Board to oversee uniformity within the SWRCB and the Regional Water Quality Control Boards.
- The state should investigate, within the current legal framework, alternative approaches to achieve more consistent and less burdensome regulatory mechanisms affecting incidental runoff of recycled

Information sources on recycled water

- *Water Recycling 2030, California Recycled water Task Force Report, 2003.*
- *SWRCB, California Municipal Wastewater Reclamation Survey, 2000.*
- *Water Recycling 2000, California's plan for the future. State Water Conservation Coalition, Reclamation/Re0use Task Force and the Bay Delta Reclamation Sub-Work Group, 1991.*
- *Southern California Comprehensive Water Reclamation and Reuse Study, Phase II. Final Report (Draft), 2000.*
- *San Francisco Bay Area Regional Water Recycling Program, Recycled Water Master Plan, 1999.*
- *Other Reports such as DWR Water Recycling Survey, 1993, California Water Plan Update 1998.*

water from use sites.

- Water Softeners. The Legislature should amend the Health and Safety Code Sections 116775 through 116795 to reduce the restrictions on local ability to impose bans on, or more stringent standards for, residential water softeners. Within the current legal provisions on water softeners, local agencies should consider publicity campaigns to educate consumers regarding the impact of self-regenerative water softeners.
- Source Control – Local agencies should maintain strong source control programs and increase public awareness of their importance in reducing pollution and ensuring a safe recycled water supply.

CALFED surface storage

CALFED's Record of Decision directed agencies and local water interests to continue with five surface storage investigations which, if implemented, would be part of CALFED's long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta. Initially, CALFED had identified surface storage as one of many potential tools to help achieve its programmatic mission and objectives. A multidisciplinary CALFED interagency team originally began with a list of fifty two potential reservoir sites. That list was reduced so that evaluation could focus on a more manageable number of sites by screening those that provided less than 200 TAF of storage or conflicted with CALFED solution principles, objectives, or policies. More specifically, CALFED policy focused on offstream reservoir sites and consideration of existing reservoir expansions. After this initial screening, twelve surface storage sites remained.

In the ROD, CALFED identified five of the twelve sites for further evaluation and consideration including North-of-the-Delta Offstream Storage, In-Delta Storage, Shasta Lake Expansion, Los Vaqueros Reservoir Expansion, and Upper San Joaquin River Storage. The five storage investigations identified in the ROD appeared to be more promising in their ability to contribute to CALFED's ecosystem, water quality, flood control and water supply objectives. In addition, the potential for implementation appeared more favorable as indicated by relative cost and stakeholder support. The ROD's listed project objectives for the five sites highlight environmental, water quality, and system flexibility needs, as well as water supply augmentation.

The planning processes for the five CALFED-directed investigations have made varying levels of progress to date. Each investigation is considering a reasonable range of alternatives. Current timelines have targeted 2005 – 2006 for completing the planning documents. Essentially, the planning consists of project formulation, environmental documentation and engineering design. By requirement and by design, these processes are intended to be open and transparent. As relevant and useful information becomes available, both stakeholders and the public are and will be notified to ensure that a broad array of input and response are incorporated into the planning activities and documentation. More specifically, as project costs, environmental effects, and benefits are compiled, regulators, the public, and ultimately decision-makers will be asked to respond to the evaluations and conclusions developed.

Sources

- *CALFED Programmatic EIS/EIR and ROD*
- *North-of-the-Delta Offstream Storage Investigation Progress Report July 2000*
- *North-of-the-Delta Offstream Storage Scoping Report, October 2002*
- *Initial Surface Water Storage Screening Report, CALFED August 2000*
- *Contra Costa Water District's Draft Project Concept Report, CALFED August 2002*
- *In-Delta Storage Program Draft Summary Report and supplemental reports on operations, water quality, engineering, environmental, and engineering evaluations May 2002*
- *Flow Regime Requirements for Habitat Restoration along the Sacramento River between Colusa and Red Bluff, Revised February 14, 2000*
- *Upper San Joaquin River Basin Storage Investigation Draft Phase 1 Investigation Report In-Progress Review, Initial Surface Storage Options Screening, November 2002*
- *Shasta Lake Water Resources Investigation Mission Statement Milestone Report, March 2003*

Planning process

*The planning process for surface storage is both comprehensive and demanding. The CALFED surface storage investigations have been developed to comply with both the state and federal environmental laws, which require extensive documentation and public involvement. In addition, implementation would likely require over 30 regulatory permits and compliances. The timing and size limitations of the characterizations here are both incomplete and brief. Both the environmental laws and the permits and compliances will allow the public to participate in a more comprehensive and informed manner and on specific issues at the appropriate time. For more information related to public involvement in the investigations, visit the DWR website at http://www.isi.water.ca.gov/ssi/index.**shtml** .*

Two illustrations

Los Vaqueros and Diamond Valley help illustrate a potential misunderstanding of benefits in applying traditional economic evaluation methods to surface storage planning efforts. Traditional economics would evaluate storage projects based on cost per acre-foot of water supply improvement. Since the "yields" of these reservoirs are incidental, the traditional cost per AF evaluation would generate almost infinite unit cost. This makes sense since these projects were not primarily developed for traditional water supply benefits. Similarly, application of traditional water supply economics for surface storage is likely not appropriate in many cases, including the CALFED surface storage investigations

Two locally developed surface storage reservoirs completed within the last five years are examples of offstream surface storage development. Both Los Vaqueros and Diamond Valley reservoirs are located offstream, indicating recognition of implementation challenges related to surface storage development on the part of the implementing agencies. Early on, CALFED came to a similar conclusion and limited studies of new surface storage to include either offstream storage or expansion of existing facilities, again highlighting the desire to reduce or avoid significant environmental effects. In addition, the use or objectives of Los Vaqueros (100,000 acre-feet capacity) and Diamond Valley (800,000 acre-feet capacity) have focused on benefits other than the traditional energy generation, flood control, and water supply augmentation of the past. The primary benefits of these new reservoirs are related to water quality, system flexibility, and system reliability against catastrophic events and droughts. More specifically, water supply augmentation is not a primary objective of either reservoir. CALFED's surface storage investigations reflect a similar approach, identifying the needs for system flexibility and water quality. However, CALFED also identifies water supply augmentation and ecosystem restoration as primary surface storage objectives as well.

Potential benefits

CALFED noted that perhaps the greatest benefit of new surface storage would be the operational flexibility that storage adds to the currently constrained system. For example, the presence of new surface storage could allow ecosystem and water managers the ability to take actions and make real-time decisions that would not be possible without additional flexibility. Also, additional water transfers between regions could be facilitated if water can be released from upstream storage at appropriate times and the receiving regions have reservoirs to store the transferred water. In addition, surface storage can improve the effectiveness of conjunctive water management strategies by more effectively capturing runoff that can ultimately be stored in groundwater basins.

The CALFED storage projects can ease the movement of water at times to improve source water quality directly or facilitate blending of water from different sources to optimize system water quality. New surface storage can help provide water resources assets for the CALFED Environmental Water Account and Environmental Water Program, and for refuges. New surface storage can also help reduce the risk associated with potential future climate change by mitigating the effects of a relatively smaller seasonal snowpack storage capacity.

The CALFED surface storage investigations are in the very preliminary stages of identifying both benefits and beneficiaries. Implementation of individual CALFED surface storage reservoirs could augment average annual water supplies by anywhere from a negligible amount to 400 TAF, depending on the mix of benefits selected by beneficiary agencies and operational considerations. The potential negligible water supply improvement could occur in the case of Los Vaqueros Expansion where the storage is operated solely for water quality.

The total amount of potential water supply improvements from implementation of all five surface storage projects is unknown since a cumulative operations study will be necessary. It is likely that some combinations of surface storage projects would provide a combined net water supply improvement (the total water supply improvement is greater than the sum of the individual improvements) while others would provide a net loss. The surface storage reservoirs could be used for agricultural and urban uses, improvement of Delta water quality for both the ecosystem and in-Delta users and exporters, improvement of streamflows during times critical for fisheries and other ecosystem processes, flexibility for changing the timing of existing diversions to protect fisheries, and other water management purposes.

Potential costs

New feasibility engineering cost estimates are in various stages of development for each of the CALFED surface storage investigations. The estimated capital cost for developing the individual surface storage projects identified in the CALFED ROD could range from $120 million (a low-end Shasta Lake Expansion) to $2.4 billion (a high-end Sites Reservoir) depending on project objectives and configurations. These capital costs do not include anticipated annual costs such as operations and maintenance, power, or costs associated with the use of existing facilities. As the investigations continue to move forward, more specific allocation of benefits will allow an economic evaluation where costs can be assigned to specific beneficiaries and benefits. Under CALFED's "beneficiaries pay" concept, all beneficiaries including water quality, environmental, system flexibility, and water supply reliability beneficiaries would pay for their share of each project's benefits.

Major issues

Consensus issues – The debate over the need for new CALFED surface storage began during development of the programmatic documents and continues now as part of the project-specific investigations. Many groups and individuals believe that more intensive demand management or implementation of other strategies can eliminate the need for new CALFED surface storage. There are additional concerns related to how the beneficiaries will be determined, who will actually pay, and who will control the storage operation. In some cases, federal authorization or local voter approval may be required.

Other groups and individuals believe that new CALFED surface storage is vital given the growing population, increasing recognition of environmental water needs, the existing inflexible system, and limited water supply. Some point to California's recent power crisis as an example of the dangers of an overly-optimistic view of supply and demand for a resource.

CALFED concluded that significant operational and water supply needs would still exist with implementation of aggressive demand management. More generally, CALFED concluded that expanding water storage capacity is critical to the successful implementation of all aspects of the CALFED Program.

Funding – The CALFED surface storage analyses, permitting and construction require major investments. Providing continuity of funding over the long development period is a major challenge. Funding for the CALFED surface storage investigations has been provided by federal and state funding sources, including voter-approved bond funds. Identification of the beneficiaries and implementation of the "beneficiaries pay" concept are untested for reservoirs providing many multipurpose and non-traditional benefits. Allocation of benefits and costs will require financial and operations agreements for the multiple beneficiaries and uses that could include operational flexibility, water quality, urban/agricultural/environmental water supply reliability, temperature control, power production or loss thereof, flood control, restoration of ecosystem processes, etc. An important issue related to beneficiaries and funding is determining what water users should pay through user fees and what the general public should pay with taxes or bond repayments.

A total of $47.4 million ($28.3 million state, $19.1 million federal) has been spent on the five CALFED surface storage investigations from fiscal years 2000-2001 through 2002-2003. To complete the five surface storage investigations, DWR and Reclamation will need an estimated additional $78.2 million. The chart below shows the breakdown of state and federal funding and projected funding needs for each fiscal year to complete the five storage investigations.

Impacts – New surface storage can cause impacts within the reservoir inundation area affecting the existing environment and human uses, economic impacts for the surrounding community, and flow impacts both up and downstream of diversions. A new reservoir can cause loss of agricultural lands and change the mix and type of jobs, or eliminate jobs in a community. New reservoirs may result in the loss of property tax revenue to local governments in the area they are located. Surface storage investigations should consider potential impacts to stream flow regimes, potential adverse effects on designated wild and scenic rivers, potential water quality issues, potential changes in stream geomorphology, loss of fish and wildlife habitat, and risk of failure during seismic and operational events. Additionally, new surface storage projects may need to address the application of Area of Origin statutes. More specific descriptions of the types of potential impacts associated with the five investigations are noted in the status summary of the five CALFED investigations.

Science –CALFED has provided a forum for independent scientific review of important project-related issues by developing a standing Science Panel. In addition, CALFED has committed to a solution principle of adaptive management that would allow operations of a CALFED-implemented facility to be modified as understanding of issues improves or new issues are identified.

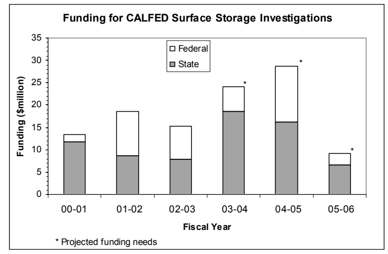
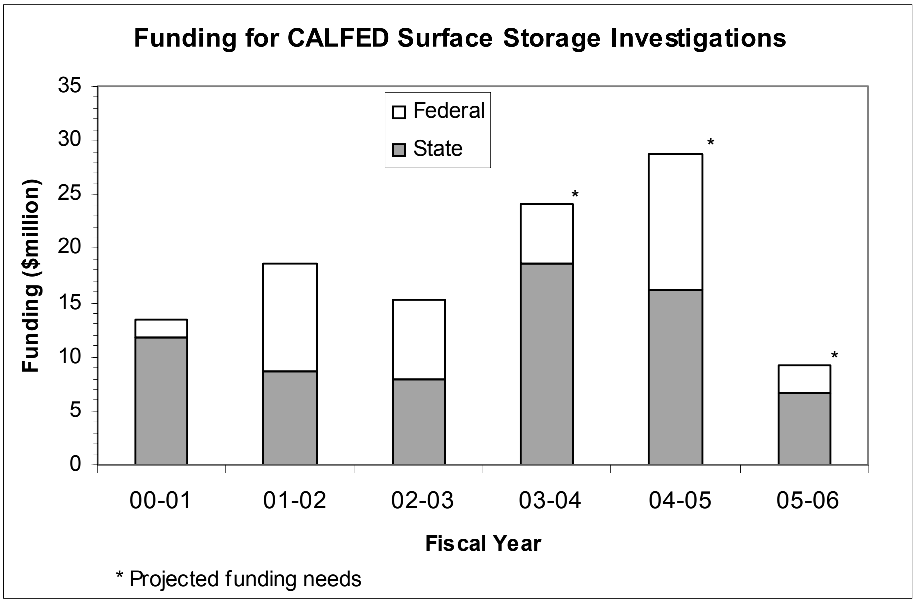


Table xx. Funding for CALFED surface storage investigations. This graph can be found at the end of this narrative. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size graph.

Recommendations

- CALFED signatories and stakeholders should finish the feasibility and environmental studies of the five potential CALFED surface storage reservoirs identified in the CALFED ROD.
- Any CALFED storage projects shall continue to be tested against CALFED Solution Principles and Implementation Commitments, including beneficiary pays and other applicable criteria for deciding to move to construction of any CALFED surface storage.
- CALFED signatories should move forward toward implementation of any surface storage reservoirs identified in the CALFED ROD that feasibly meet project objectives and satisfy the CALFED Solution Principles and Implementation Commitments including commitments specific to surface storage such as that described in Recommendation 4 below.

- In development of new surface storage, DWR leadership should work to achieve CALFED solution principles and the CALFED commitment that, "new groundwater and surface storage will be developed and constructed, together with aggressive implementation of water conservation, recycling, and a protective water transfer market, as appropriate to meet CALFED Program goals."


Funding for CALFED Surface Storage Investigations
Federal
State
Funding ($million)
0
5
10
15
20
25
30
35
00-01
01-02
02-03
03-04
04-05
05-06
Fiscal Year
*
* Projected funding needs

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Preliminary Capital Cost and Water Supply Improvement Estimates for the CALFED Surface Storage Projects

(1) There is a wide range of capital costs for the storage projects due to the wide range of options for storage and storage capacity,pumping plants, intakes, conveyance facilities, and inlet/outlet works being studied. The capital cost estimates are based on 2002-2003 estimates.
(2) The range of storage capacity for Shasta Lake Enlargement, Los Vaqueros Reservoir Expansion, and Upper San Joaquin River Storage reflects the range of storage options being studied.
(3) These are the projects' objectives as specified in the CALFED Record of Decision.
(4) The non-water supply benefits are those such as water quality improvement and ecosystem restoration that are not quantifiable but are major benefits of the projects.
(5) These are average annual water supply improvements, except where noted, and are defined as additional deliveries above the existing baseline and are estimated from preliminary model runs. The wide range of water supply improvements for the storage projects reflects the various operational scenarios.
* Pumping and operations and maintenance costs are not available and not included in the cost estimates.

	(1)	(2)	(3)	(4)	(5)
Surface Storage Project	Capital Cost Estimates ($ millions)	Storage Capacity (taf)	CALFED ROD Objectives	Non-Water Supply Benefits Being Identified	Water Supply Improvements Estimates (taf)
North-of-the-Delta Offstream Storage (Sites Reservoir Alternative)	$1,000 – $2,000	1,800	Enhance water management flexibility in the Sacramento Valley Reduce water diversion on the Sacramento River during critical fish migration periods Increase reliability of supplies for Sacramento Valley Provide storage and operational benefits for other CALFED programs including Delta water quality and the EWA	Water quality improvement Ecosystem restoration in Sacramento River Water management flexibility in Sacramento Valley	100 – 400
In-Delta Storage	$500 - $800	200	Provide both fishery benefits and enhanced water project flexibility	Ecosystem restoration in Delta	90 – 170
Shasta Lake Expansion	$120 - $430	300 - 1020	Increase pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish Provide other water management benefits, such as water supply reliability	Ecosystem restoration in Sacramento River	50 – 110
Los Vaqueros Reservoir Expansion	$870 – $1,300	200 - 400	Provide water quality and water supply reliability (drought storage and emergency supply) benefits to Bay Area water users	Water quality improvement Water management flexibility in Delta Ecosystem restoration in Delta Storage for environmental water	0 – 60 (dry year average annual water supply)
Upper San Joaquin River Storage	$450 - $800	450 – 1,200	Provide additional water to help restore and improve habitat and water quality in the San Joaquin River Facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities	Water quality improvement Ecosystem restoration in San Joaquin River	100 – 200
For comparison purposes, the costs, capacity, and objectives of the two recently completed offstream storage projects in California are shown below.					
Existing Los Vaqueros Reservoir	$450 (circa 1988)	100	Improve water quality for Contra Costa Water District customers Minimize seasonal quality changes Improve the reliability of the CCWD supply by providing emergency storage	Same as objectives defined in Column (3)	Not Developed for Water Supply
Existing Diamond Valley Reservoir	$2,000 (circa 1998)	800	Provide emergency water reserves Provide partial remediation of water shortages during cyclical droughts Meet seasonal operating requirements Preserve operating reliability during service repairs Assist the recharge of groundwater basins	Same as objectives defined in Column (3)	Not Developed for Water Supply

Prelininary capital cost and water supply improevment estimates for the SALFED surface storage projects

Status of the five CALFED surface storage investigations

Please note:

This article will be located in Volume 3, the Reference Guide, when the Update is completed. It is presented here for your comments.

The following status description of the five CALFED surface storage investigations is presented here to provide a current overview of the planning processes. While the Water Plan did not intend to evaluate or even discuss specific projects associated with the strategies, it seems appropriate here since the California Department of Water Resources is the CALFED lead State agency for investigating storage.

DWR and the U.S. Bureau of Reclamation are partners with local water interests and other State and Federal agencies to study five surface storage projects as part of the CALFED Bay-Delta Program's long-term plan for restoring ecological health and improving water management for beneficial uses of the Bay-Delta. The five storage projects under study are Shasta Lake Expansion, North-of-the-Delta Offstream Storage, In-Delta Storage, Los Vaqueros Reservoir Expansion, and Upper San Joaquin River Storage.

The five surface storage projects are part of CALFED's water management strategy that combines storage (both groundwater and surface storage) with other water management actions including conservation, recycling, conveyance, and transfers to achieve CALFED program objectives including ecosystem restoration, water quality improvements, and water supply reliability improvements. The primary challenge in developing the strategy is finding the appropriate mix of actions and associated achievement of objectives. The CALFED Record of Decision concluded that additional storage is critical to the successful implementation of all aspects of the CALFED Program.

DWR and Reclamation are studying these five storage projects in an open, transparent, and inclusive process. An initial list of project objectives were included in the ROD and have subsequently been refined with more specific benefits listings for several of the projects.

A brief description of each of the five surface storage projects is provided below.

Shasta Lake expansion

Reclamation, in coordination with DWR and other agencies, is conducting a feasibility study to evaluate the potential for expanding Shasta Dam and Lake.

The objectives specified in the CALFED ROD for Shasta Lake Expansion are to increase the pool of cold water available to maintain lower

Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.

Potential benefits for Shasta Lake Expansion include:

- Increase the survival of anadromous fish populations in the Sacramento River primarily upstream from the Red Bluff Diversion Dam.
- Increase water supplies and water supply reliability for agricultural, M&I, and environmental purposes to the CVP to help meet future water demands with a primary focus on modification of Shasta Dam and Reservoir.
- Preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River.
- Reduce flood damages along the Sacramento River.
- Develop additional hydropower capabilities at Shasta Dam.
- Provide additional water-related recreational opportunities in the Shasta Lake area.

The study will identify potential project alternatives and assess likely project benefits, adverse effects, and mitigation strategies. One alternative being formulated and evaluated, as identified in the CALFED ROD, is to expand Shasta Lake by about 290,000 acre-feet by raising the height of Shasta Dam 6.5 feet. Other potential alternatives include additional dam modifications, reservoir re-operations, and conjunctive use opportunities.

Raising the height of Shasta Dam by 6.5 feet would relatively briefly and infrequently inundate a small portion of stream habitat on the McCloud River protected by California Public Resources Code 5093, the Wild and Scenic Rivers Act. Coordination continues with landowners on the McCloud River arm to complete environmental surveys that address potential adverse impacts to the wild and scenic status of the river.

The feasibility report and environmental documentation are expected to be completed in 2006.

North-of-the-Delta offstream storage

DWR, Reclamation, and their partners are studying a proposal to develop offstream storage north of the Sacramento–San Joaquin Delta. The investigation includes Sites Reservoir and alternatives. The Sites Reservoir is about 70 miles northwest of Sacramento in Antelope Valley and can store up to 1.8 million acre-feet of water.

The objectives specified in the CALFED ROD for North-of-the-Delta Offstream Storage are to enhance water management flexibility in the Sacramento Valley. By reducing water diversion on the Sacramento River during critical fish migration periods, this project can greatly increase reliability of supplies for a significant portion of the Sacramento Valley. It can also provide storage and operational benefits for other CALFED programs including Delta water quality and the Environmental Water Account.

Potential benefits of North-of-the-Delta Offstream Storage include:

- Improve water supply reliability for local agricultural service contractors
- Improve water supply reliability for Sacramento Valley Refuges
- Provide water for rice decomposition in Sacramento Valley
- Improve water supply reliability for south of Delta CVP and SWP contractors
- Improve Delta water quality
- Reduce diversion from the Sacramento River during critical fish migration periods
- Provide water and storage for CALFED’s Environmental Water Account
- Provide water for CALFED’s Ecosystem Restoration Program objectives

Glenn-Colusa Irrigation District, Tehama-Colusa Canal Authority, California Department of Fish and Game, U.S. Fish and Wildlife Service, DWR, and Reclamation are working with a partnership of local water agencies and other State and federal agencies. The partnership has signed a Memorandum of Understanding to cooperatively investigate North-of-the-Delta Offstream Storage.

Scoping meetings were held in January 2002 to identify important issues and environmental considerations. A scoping report was completed in October 2002.

Early on in the consideration of offstream storage located north of the Delta, stakeholders identified potential effects to the flow regime of the Sacramento River and associated ecosystem processes as significant concerns. The partnership requested establishment of a Flow Regime Technical Advisory Group to understand and document scientific understanding related to the flow regime of the river. In addition, the group, comprised of local, state, and federal resource entities as well as university scientists and environmental advocates and scientists, are assisting in the development of operations concepts related to potential diversions from the Sacramento River. A summary report of the advisory group's effort will be published with review provided by the CALFED Science Panel.

DWR, Reclamation, and the partnership are working on a feasibility study and environmental documentation that are expected to be completed in 2005.

In-Delta storage

DWR, with technical assistance from Reclamation, is assessing technical and financial feasibility of developing new storage in the Delta. The project would divert and store water on islands in the Delta. Two Delta islands, Webb Tract and Bacon Island, would be converted into reservoirs with a capacity of 217,000 AF; two islands, Bouldin Island and Holland Tract, would be managed as wetland and wildlife habitat.

The objectives specified in the CALFED ROD for In-Delta Storage are to provide both fishery benefits and enhanced water project flexibility.

Potential benefits of In-Delta Storage include:

- help meet the ecosystem needs of the Sacramento-San Joaquin Delta, Environmental Water Account, and Central Valley Project Improvement Act goals
- provide water for use in the Delta
- increase reliability, operational flexibility, and water availability for use south-of-the Delta by the State Water Project and Central Valley Project

During the Planning Phase of the study, DWR and Reclamation have evaluated the proposed operations and engineering of the original Delta Wetlands proposal for storage on Webb Tract and Bacon Island, as well as water quality and environmental and economic impacts, and found that it is generally well planned. However, the project needed to be modified for public ownership and additional analysis was required to resolve issues related to embankment design, water quality, and risk of failure. These issues and analyses need to be resolved and completed before negotiating with Delta Wetlands Properties and others to purchase or lease the land involved in this project. DWR and Reclamation have also evaluated numerous combinations of Delta islands as alternatives to provide In-Delta Storage benefits.

DWR and Reclamation will continue to work with stakeholders to identify changes necessary to make the project suitable for public ownership. DWR, in coordination with Reclamation and the California Bay-Delta Authority, is conducting technical and financial feasibility studies needed to help CALFED agencies decide whether or not to negotiate with Delta Wetlands owners to acquire the necessary property.

In the ongoing feasibility study, scheduled for completion in July 2003, DWR and Reclamation have conducted analyses of the issues related to engineering design, risk analysis, water quality and climate change. The DWR Independent Board of Engineering Consultants has reviewed and concluded that engineering design and risk analysis studies are meeting the feasibility level analysis requirements. A CALFED Science Panel workshop is scheduled for August 2003 that will review studies related to project operations, environmental effects, and drinking water quality at the urban intakes in the Delta. Concerns associated with drinking water quality are related to organic carbon, temperature and dissolved oxygen levels.

Climate change may result in raising water levels surrounding the project islands and also may change the timing of winter and spring inflows into the Delta. These effects may require additional operational considerations and maintenance costs.

DWR will submit a State feasibility report in to the Bay-Delta Public Advisory Committee in December 2003 with a recommendation on whether or not to proceed with the project. If a decision is made to proceed with the project, a subsequent EIS/EIR will be prepared and completed in 2005.

Los Vaqueros Reservoir expansion

CALFED's Los Vaqueros Reservoir Expansion studies will assess the feasibility, environmental benefits, and impacts of expanding the existing Los Vaqueros Reservoir from its current capacity of 100,000 acre-feet to a capacity of 500,000 acre-feet.

The objectives specified in the CALFED ROD for the Los Vaqueros Reservoir Expansion are to provide water quality and water supply reliability benefits to Bay Area water users.

Initial studies began in January 2001. The studies focused on determining if the project could meet CALFED's program goals and the participation principles, which include a requirement for local voter approval, adopted by Contra Costa Water District's Board of Directors.

The studies will define project benefits and address public comments. On June 25, 2003, the CCWD Board of Directors voted unanimously to approve ballot language to seek voter approval for further study. If the project meets CCWD's participation principles and receives voter approval, environmental documentation and engineering studies will be prepared in 2004 and completed in 2005.

Upper San Joaquin River storage

Reclamation, in coordination with DWR, local partners and other state and federal agencies, is evaluating an increase of 250,000 to 700,000 acre-feet of storage in the upper San Joaquin River watershed. This additional storage would be obtained by raising the height of Friant Dam to expand Millerton Lake - or by a similar storage program.

The objectives specified in the CALFED ROD for the Upper San Joaquin River Storage are to contribute to restoration of and improve water quality for the San Joaquin River and facilitate conjunctive water management and water exchanges that improve the quality of water deliveries to urban communities.

Reclamation, DWR, and their partners have developed a two-phased planning process. Phase 1 will identify water resource opportunities and issues in the Upper San Joaquin River watershed. This phase will appraise opportunities to increase surface storage and conjunctive use of groundwater and recommend whether or not to proceed with a feasibility-level study (Phase 2). Phase 2 will be more detailed and will begin with public meetings to receive comments on the scope of the study. Phase 2 will include all necessary environmental documentation.

The feasibility report and environmental documentation are expected to be completed in 2006.

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Surface storage - regional/local

This strategy covers regional and local surface storage alternatives not currently under state and federal investigations as described in the CALFED Record of Decision. The CALFED /State Surface Storage alternatives are described in a separate strategy narrative.

Surface storage is the use of reservoirs to collect water typically for later release and use. Surface storage has played an important role in California where the pattern and timing of water use does not always match the natural runoff pattern. Most California water agencies currently rely on surface storage as a part of their water systems. Similarly, surface storage is often necessary for, or can increase, benefits from other water management activities such as water transfers, conjunctive management and conveyance improvements. Some reservoirs contribute to water deliveries across several regions and some only contribute to water deliveries within the same watershed. In addition to water supply augmentation and system flexibility, other objectives of multi-purpose surface storage facilities can include the following: flood management, hydroelectric power production, recreation, water quality improvements, sediment management, emergency water supply and environmental benefits.

Surface reservoirs can be formed by building dams across active streams or by building off-stream reservoirs where the majority of the water is diverted into storage from a nearby water source. Surface storage capacity can also be developed by enlarging, reoperating or modifying outlet works on existing reservoirs. Smaller reservoirs typically store water in one season for use in another season, while larger reservoirs can do the same or store water for use over several years. Reoperation of facilities is treated in a separate strategy narrative.

Current status

California has nearly 200 surface storage reservoirs greater than 10,000 acre-feet with a combined storage capacity of over 41 million acre-feet. In addition, many smaller reservoirs are used to provide for a wide range of water uses, stabilize water delivery to customers and provide a backup for emergency supply. Similar to many other parts of the world, most California reservoirs were developed over 30 years ago. As of the mid 1990s, there were about 1,242 dams (see footnote, right) under construction worldwide – 55 in the United States. In California, nearly 40 dams (see footnote, right) have been constructed over the last decade. Examples of

Footnotes

1. United States Society on Dams, November 2000

2. Source: CA Division of Safety of Dams; includes DSOD jurisdictional dams only.

recently completed reservoirs that are not part of the CALFED planning process include: Olivenhain, Los Vaqueros, Diamond Valley and Seven Oaks reservoirs. The first three examples are located offstream, indicating recognition of implementation challenges related to surface storage development on the part of the implementing agencies. The primary benefits of these new reservoirs are related to flood control (Seven Oaks), water quality, system flexibility, and system reliability against catastrophic events and droughts. Water supply augmentation is not a primary objective of any of the new reservoirs.

Over the past several decades, ecosystems and fisheries in particular have benefited from surface storage reservoirs through regulation and legislation. Specifically, many existing reservoirs have been (and continue to be capable of being) adaptively managed to achieve ecosystem and other benefits beyond water supply. There are *net* environmental effects induced by new and existing surface storage facility operations. For instance, if the benefits of environmental releases serve to simply mitigate impacts caused by said facilities, then the net effect on the environment could still be negative. As both environmental and urban uses have grown, the state's surface water system has become increasingly inflexible. However, the system has still been able to expand or increase its benefits since historically some aspects of the system (particularly conveyance) have been underutilized compared to current use. Water and ecosystem managers have less ability to adapt as use and regulatory requirements frequently control operations.

The relative need for local surface storage development may be greatest in the interior mountainous areas of the state such as the Cascades and the Sierra Nevada. Although much of the water used throughout the state originates in the mountains, which generally possess a much narrower array of available water management strategies to meet local needs. This is largely due to geographic, hydrogeologic or hydrologic limitations. Of these few strategies, some form of surface storage may hold the greatest potential for achieving local supply reliability objectives. Local surface storage development options include the reoperation of existing reservoirs, increasing the yield of existing reservoirs by expanding their capacities, or construction of new reservoirs. Most of the best reservoir sites have already been used and the new standards of environmental regulations are significant constraints to development of surface storage in the mountain areas.

The range of surface storage development options for smaller local agencies is more limited than for the state and federal governments. Local agencies have limited ability to use state or federal funds, nor do they have the ability to work as closely with their corresponding resource regulatory agencies such as the state and federal agencies do as part of CALFED, for example. Additionally, there are physical limitations on storage options in some parts of the state. In some areas, offstream storage is not feasible. These circumstances severely constrain the ability of water resources entities within these geographic areas to locally finance and implement the projects necessary to sustain the local economy and serve often increasing populations.

Potential benefits

Many of California's reservoirs were originally built for hydropower, flood control, and consumptive use. Although the allocation of benefits for proposed surface storage can affect the occurrence and magnitude of different types of benefits, they generally can include the following:

- water quality management
- system operational flexibility
- power generation
- flood management
- ecosystem management
- sediment transport management
- recreation
- water supply augmentation
- emergency water supply

Surface storage reservoirs have allowed development of significant benefits including water supplies for human use, but have also contributed to significant environmental impacts – not all of which have been or can be mitigated. For example, water stored in and released from reservoirs has significantly altered the natural flows in many California streams, affecting water temperature and riverine habitats.

The presence of new surface storage could allow ecosystem and water managers the ability to take actions and make real-time decisions that would not be possible without additional flexibility. Additional water transfers between regions could be facilitated if water can be released from upstream storage at appropriate times and the receiving regions have reservoirs to store the transferred water. Surface storage can improve the effectiveness of conjunctive water management strategies by more effectively capturing runoff that can ultimately be stored in groundwater basins.

Storage projects can improve the movement of water at times to improve source water quality directly or facilitate blending of water from different sources to optimize system water quality. New surface storage can help provide water resources assets for the CALFED Environmental Water Account and Environmental Water Program, and for refuges. New surface storage can also help reduce the risk associated with potential future climate change by mitigating the effects of a relatively smaller seasonal snowpack storage capacity as well as increased and/or more sustained peak flood flows.

There are some opportunities for local storage projects, either on or offstream, which could provide local operational benefits, flood management and new supplies independent of CALFED initiatives. Finally, there may be large-scale federal projects that are more economically or environmentally favorable, or have been authorized for construction in coming years. At this time, none of those projects are actively moving ahead.

Potential costs

The type and magnitude of benefits of additional multipurpose surface storage (new or enlarged) will vary significantly based on the allocation of benefits as spelled out in the *Potential Benefits* section above. Benefit and cost estimates for potential surface storage alternatives are not specified in this narrative – mostly due to the benefit-allocation complexity described above. In essence, benefits and unit cost estimates are only useful if created for a specific project with a defined allocation of benefits and costs (e.g. 20 percent flood control, 30 percent water quality, 10 percent environmental, 10 percent hydropower, 10 percent system flexibility, 20 percent water supply). However, it is important to point out that there are other options for new storage that may be more cost effective than the CALFED proposals from a water supply improvement standpoint since cost effectiveness was only one of many criteria considered in that process.

Major issues

Consensus Issues – The debate over the need for new surface storage is one of the biggest issues facing California water management. Many groups and individuals believe that more intensive demand management or implementation of other strategies can eliminate the need for new surface storage. There are additional concerns related to how the beneficiaries will be determined, who will actually pay, and who will control the storage operation. In some cases, federal authorization or local voter approval may be required. Other groups and individuals believe that new surface storage is vital given the growing population, increasing recognition of environmental water needs, the existing inflexible system, and limited water supply. Some point to California's recent power crisis as an example of the dangers of an overly-optimistic view of supply and demand for a resource.

Funding - Regardless of the potential contribution to economically efficient water management, identifying sources of sufficient funds for construction (i.e. financial feasibility) presents a challenge. Implementation usually requires large sums of money dispersed over a period of time with a high level of reliability — perhaps $1 billion over five years for larger projects. Included in the long-term capital outlay are planning costs such as administrative, engineering, legal, financing, permitting and mitigation which can also require significant investments. Some new storage options such as raising existing reservoirs, reoperating them or the construction of small local reservoirs may require significantly less capital cost, but may require local funding through revenue or general obligation bonds. Even these less costly projects would face financial challenges.

Allocation of benefits and costs – The challenge is to develop financial and operations agreements for the multiple beneficiaries and uses that could include operational flexibility, water quality, urban/agricultural/environmental water supply reliability, temperature control, power production or loss thereof, flood management, restoration of ecosystem processes, etc. An important issue related to beneficiaries and funding is determining what water users should pay through user fees and what the general public should pay with taxes or bond repayments.

Impacts – New surface storage causes both positive and negative impacts within the reservoir inundation area as well as human communities and natural watercourses. While the positive impacts are discussed in the *Potential Benefits* section of this narrative, many of the "issues" revolve around the negative impacts. New storage can affect the existing environmental and human conditions, create economic impacts for the surrounding community, and flow impacts both up and downstream of diversions. New reservoirs may impact local land use resulting in the loss of property tax revenue to local governments in the area they are located, or by increasing local property values by firming up a water supply. Regulatory and permitting requirements require surface storage investigations to consider potential impacts to stream flow regimes, potential adverse effects on designated wild and scenic rivers, potential water quality issues, potential changes in stream geomorphology, loss of fish and wildlife habitat, and risk of failure during seismic and operational events. Additionally, new surface storage projects may need to address the application of Area of Origin statutes.

Science – Biologists and water managers continue to struggle to identify and understand the relationships between hydrodynamics, flow timing, water temperature, geomorphology, water quality, environmental responses, and other conveyance related considerations. Increased understanding of these considerations will enable resource planners and managers to better determine the causes of observed impacts and hence, more effectively restore, preserve and manage at-risk resources (e.g., modified operations and environmental mitigation).

Recommendations

- Local agencies seeking to implement storage projects should develop a comprehensive methodology for analyzing all benefits and full costs of projects. DWR should provide technical expertise and assistance to the local agencies upon request in this effort – while minimizing redundancies with existing environmental compliance and permitting requirements.
- Local agencies' projects need not be measured against CALFED solution principles, implementation commitments, or objectives by State agencies – unless local proponent is seeking State finding. However, CALFED solution principles are certainly worth considering since they may provide a greater route to success.
- Reservoir operators and stakeholders should continue to adaptively manage operations of existing facilities in response to increased understanding of system complexities and demands as well as changes in natural and human considerations such as social values, hydrology, and climate change.
- DWR and other local, state and federal resource management agencies should continue to engage in studies, research and dialogue focused on a common set of tools that would increase the public understanding and perception of the full range of benefits and impacts as well as the costs and complexities of surface storage projects.
- Water resources planners should respond to planning and implementation challenges by providing adequate foresight and continuity in funding for planning, environmental studies and permits, design and construction.

System Reoperation

In Progress

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Urban land use management

The way in which we use land—the types of use and the level of intensity—has a direct relationship to water supply and quality. Development and population growth have traditionally been considered determining factors in water demand. This is especially true in the analysis of the relationship between water demand and suburban or urban development. This relationship is most often viewed in terms of mitigation strategies. How different physical patterns of development affect water demand is seldom considered, but can have a huge impact on water supply and quality.

Current development patterns in California

The term sprawl is used to refer to a land use development pattern characterized by fragmented and segregated land uses, low density residential and strip commercial development, and a lack of connectivity within and between neighborhoods. This development pattern can consume large quantities of land per capita. The result is the consumption of more prime farmland, open space, habitat, and an increased impact on other natural resources. Those living in sprawl rely primarily on the automobile to connect them to jobs, services, and community amenities. In a sprawl land use pattern, transportation alternatives such as walking, biking, and public transportation are unsafe, ineffective, or not economically feasible.

The reliance on automobiles causes additional environmental and social burdens. A sprawl development pattern results in the construction of an extensive road system and an increase in vehicle miles traveled. The creation of large amounts of impervious surfaces, such as roads and parking lots, results in the degradation of water quality by increasing surface runoff, altering stream flow and watershed hydrology, reducing groundwater recharge, and increasing stream sedimentation. It also increases the danger of flooding.

A sprawling development pattern may provide cheaper land to developers and less expensive home prices, but there can be high costs to homeowners in the form of special taxes and fees to provide and maintain infrastructure. In the long-term, local governments face budget deficits because the costs to provide services and maintain infrastructure are often not fully reimbursed by property taxes. This can result in higher service fees to homeowners, or to a decline in the quality of service. Additionally, there are both economic and quality of life costs that result from environmental degradation, such as increased air and water pollution, traffic congestion, competition for limited water resources, and lack of parks, open space, and habitat.

California needs a development pattern that assures a high quality of life for future generations. This is both an economic and environmental challenge. In order to attract economic development, we need to create communities that have safe, healthy environments. Residents need to be able to easily access jobs, housing, education, and community amenities. The natural and cultural resources that make our state unique must be preserved. Growth does not prevent this from happening. Growth can be managed to improve our communities. In some of the most densely populated regions of the state, including the San Francisco Bay Area and Los Angeles, headway is being made to grow more compactly, provide jobs close to housing, provide transit to connect people with community resources and opportunities, and to mix land uses for a more vibrant social fabric.

In 2002, the Governor signed AB 857, establishing three new state planning priorities that encourage a new development pattern for the state. These priorities organize state capital and infrastructure investments around infill development, protection of environmental and agricultural resources, and compact development that is contiguous to existing development and infrastructure. These statutorily mandated land use planning principles recognize the need for state agencies to coordinate their actions. This allows the state to use its limited resources to maintain its economic competitiveness and its high quality of life for future generations.

Potential benefits

This new resource efficient development pattern focuses on using existing infrastructure and building more compact development that supports walking, biking, and public transit. It encourages a mix of land uses and a balance of jobs and housing both of which reduce time and miles spend in automobiles. There are numerous water-related benefits that accrue from resource efficient development. It requires less water and minimizes pollution of our surface and groundwater. In addition, by focussing on infill first, and compact greenfield development second, impacts to habitat, watershed functions, and groundwater recharge areas are reduced.

Compact, mixed-use development can reduce water demand, even with moderate increases in density. As a rule of thumb, landscaping irrigation accounts for almost half of residential water usage. An increase in residential density from four units per acre to five reduces the landscaping area by 20%, which should cut water usage by roughly 10% compared to the lower density development.

A smaller urban footprint reduces impervious surfaces. This generates less surface runoff and sediment load, and minimizes intrusion into watersheds and groundwater recharge areas which receive the runoff and sediment. Less interference with natural systems can also reduce the frequency and severity of flood events.

Studies in New Jersey and South Carolina found that when compact development, that encourages open space, was compared to current sprawl patterns, compact development reduced the amount of runoff and pollution. In the New Jersey study, the compact development pattern reduced pollution from 10 percent for lead, to 40 percent for nitrogen and phosphorus over a 20 year period. In South Carolina, a compact town development model produced 43 percent less runoff than a sprawl model.

Potential costs

Cost savings may result from reduced costs to treat and store surface runoff. There may also be a reduction in costs related to flooding and its impacts. Resource efficient development requires less infrastructure expansion to increase water supply, and lower mitigation costs for development impacts on agricultural land and wildlife habitat. The New Jersey study found that compact development that clustered single-family homes, and had more attached single-family homes and multifamily developments, reduced water and wastewater infrastructure costs. This was because demand was decreased and less physical infrastructure was needed.

There will be new costs associated with changing the way local, regional, and state agencies plan our urban areas. Among these are costs for increased communication and coordination between land use agencies, water suppliers, and agencies which regulate water quality. Increased coordination among all levels of government will be necessary to coordinate inter-agency planning efforts, to develop information databases, and to interpret and share data and information.

State and local development codes, including zoning ordinances and building codes, may need to be changed to facilitate a more resource efficient development model. There may be costs to educate the public, decision-makers, and the development community about the benefits of resource efficient development. Funding institutions, including state government agencies, may need to target water quality and water supply funding programs to encourage infill and compact development.

Infill development often requires the upgrading of existing infrastructure to increase its capacity. These infrastructure costs may be offset in the long run buy avoiding the costs of infrastructure and municipal service expansion that sprawling development patterns require. Most of the costs associated with using a resource efficient development pattern seem to be short-term, while the cost savings are more long-term. Ultimately, if we do not plan now for the efficient use of water, the cost will be born by all the residents of the state in reduced economic opportunity and a decline in quality of life.

Major issues

Disincentives for change – Local governments make most of the land use decisions in California. There are many reasons why local governments continue to approve sprawl development including: financial disincentives for balanced growth, community resistance to infill or higher density development, institutional biases in local zoning ordinances which have not been updated for many years, and traditional environmental mitigation strategies that encourage lower density development.

State's role – Historically, the State impacted land use through the siting of state facilities and through funding assistance for local infrastructure development. With the recent passage of AB 857, state agencies are required to promote more resource efficient land use patterns. State functional plans and capital investment decisions must be consistent with the planning priorities of AB 857. In the case of proposed state capital improvements, they will not be included in the state's five-year infrastructure plan until they are consistent with the planning priorities. This will indirectly, but powerfully influence local land use decisions.

Role of Local Agency Formation Commissions - LAFCOs are regional planning agencies that were established to encourage logical and efficient development patterns. They have not always fully employed their decision-making authority to discourage sprawl development. With the recent passage of AB 2838 (LAFCO reform), LAFCOs are now required to perform municipal service reviews on a regular basis. This will allow a comprehensive evaluation of how all services, including water, are delivered to developing areas of the State.

Water supply and growth - SB 221/610 requires local governments to determine whether there will be sufficient water to supply a proposed development project before it can be approved. This will require land use agencies and water agencies to communicate and coordinate on project-level development decisions. It is an important milestone because it recognizes the critical relationship between land use and water.

Recommendations

State of California - statutory requirements

- All state agencies that influence land use development or infrastructure development must update their strategic and functional plans to be consistent with the three planning priorities of AB 857.
- All state agency funding requests for infrastructure or capital improvements must be consistent with the three new planning priorities of AB 857 before they can be included in the state's five-year Infrastructure Plan.
- State infrastructure investments, including investments in water supply infrastructure, should be consistent with the goals and policies of the EGPR, which include coordinated state planning and spending decisions that minimize land use conflicts and discourage sprawl.

General

- Provide incentives to developers and local governments to plan and build using more resource efficient development patterns. This can be done through prioritizing planning and infrastructure grants to encourage infill and compact development forms.
- Provide technical assistance to local and regional government agencies on how to implement SB 221/610 and how to prepare adequate water supply assessments before approving major new development projects.
- Provide technical assistance to local governments on how to incorporate resource efficient development into their local general plan, related zoning ordinances, and specific plans.
- Encourage local governments to adopt general plan land use policies that recognize the importance of coordinated land use planning and water supply planning.
- Encourage local governments to adopt a water element in their general plans (as suggested in the OPR General Plan Guidelines).
- Develop and publicize accurate and relevant data on water supply

and water quality to help local agencies in their planning efforts.

- Encourage further research on the impacts of resource efficient development patterns and best practices.

Local government

- Recognize regional needs and resources when designing and building neighborhoods and communities. Coordinate with other local agencies, regional planning agencies, and local water agencies and watershed managers.
- Promote the rehabilitation of aging or inadequate infrastructure to facilitate infill development.
- Direct new development away from prime agricultural land, open space, flood plains, recharge areas and wetlands to areas where there is existing infrastructure .
- Encourage less water intensive landscaping.
- Reduce the amount of impervious surfaces used in development especially near waterways.

Regional government

- LAFCOs, councils of governments (COGs), and watershed planning organizations should participate in the development of local general plans by offering policy recommendations that are supported by data and information.
- LAFCOs should consider water supply and water quality issues in the context of their charge to encourage logical and efficient development patterns that minimize impacts on agricultural land and maximize housing affordability.

Water suppliers

- Develop and make available water resource information (water supply and water quality) to local governments that can be used in local and regional land use decisions, including general plan formulation and municipal service reviews.
- Collaborate on assessing water supply availability for new development.

Urban runoff management

Urban runoff management is a broad series of activities undertaken to manage both stormwater and dry weather runoff. Dry weather runoff occurs when, for example, excess landscape irrigation water flows to the storm drain. The primary benefits from urban runoff management are to reduce nonpoint source water pollution and improve flood protection. Additional benefits may be to increase water supply through groundwater recharge, and improve and increase wildlife habitat, parks and open space. Urban runoff management is linked to several other resource strategies including land use management, watershed management, water use efficiency, recycled water, protecting recharge areas, and conjunctive management. Traditionally, urban runoff management was viewed as a response to flood control concerns resulting from the effects of urbanization. Concerns about the water quality impacts of urban runoff have led water agencies to look at watershed approaches to control runoff and provide other benefits. These two strategies can be used in combination, each with advantages and disadvantages as described below.

With the traditional approach, urban runoff is viewed as a flood control problem and it is conveyed as quickly as possible from urban areas to waterways to get rid of it. Urbanization alters flow pathways, water storage, pollutant levels, and rates of evaporation, groundwater recharge and surface runoff, and alters the timing and extent of flooding, the sediment yield of rivers, and the suitability and viability of aquatic habitats. The traditional approach has been successful at preventing flood damage, but has several disadvantages. In order to convey water quickly, natural waterways are often straightened and lined with concrete, resulting in a loss of habitat, a reduction in groundwater recharge from streams, and impacts to natural stream physical and biological processes. This strategy collects pollutants and increases the timing and volume of runoff as it moves towards its final destination resulting in pollution, stream bank erosion, and potentially flooding problems downstream. Because of the emphasis on removing the water quickly, the opportunity to use water for multiple benefits is limited.

The watershed strategy for urban runoff management tries to emulate and preserve the natural hydrologic cycle that has been altered by urbanization. The watershed strategy consists of a series of best management practices (BMPs) designed to reduce the pollutant load, timing, and volume of urban runoff reaching waterways. These BMPs may include requiring new developments to capture, treat, and recharge groundwater with urban runoff, conducting public education campaigns for the proper

Objectives of urban runoff management

- *Protection and restoration of surface waters by the minimization of pollutant loadings and negative impacts resulting from urbanization*
- *Protection of environmental quality and social well-being*
- *Protection of natural resources, e.g., wetlands and other important aquatic and terrestrial ecosystems*
- *Minimization of soil erosion and sedimentation problems*
- *Maintenance of the predevelopment hydrologic conditions*
- *Protection of ground-water resources*
- *Control and management of runoff to reduce or prevent flooding*
- *Management of aquatic and riparian resources for active and passive pollution control*

use and disposal of household chemicals, and providing technical assistance and storm water pollution prevention training. Some areas have studied collecting rainfall from roofs into cisterns for later use as supply. Methods for recharging groundwater with urban runoff include draining runoff from parking lots, driveways, and walkways into landscape areas with permeable soils, using drywells, using permeable surfaces. These BMPs may include source control and pretreatment before infiltration. Infiltration enables the soil to naturally filter many of the pollutants found in runoff and reduces the volume and pollutant load of the remaining water when it reaches the outfall. The watershed strategy will not prevent all urban runoff from entering waterways, so elements of the traditional conveyance and storage strategy will still be needed. The ability to recharge urban runoff is dependent on the soil and geology where recharge is to occur.

Current status

Urban runoff management has become more important and controversial over the last decade as municipal governments have been held increasingly responsible for nonpoint source pollutants washed into waterways from developed areas within their jurisdictions. Nonpoint source pollution, unlike pollution from industrial and sewage treatment plants, comes from many diffuse sources. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters, and potentially into groundwater. Nonpoint source pollution also occurs from non-storm event activities, such as aerial deposition, dry weather flows from landscape irrigation, improper disposal of trash or yard waste, and leaky septic systems.

The 1987 amendments to the federal Clean Water Act directed the U.S. Environmental Protection Agency (USEPA) to establish a permitting system under the National Pollutant Discharge Elimination System (NPDES) to regulate nonpoint source pollution from certain urban areas in order to protect water quality. In California, the authority to regulate urban and stormwater runoff under the NPDES system has been delegated by USEPA to the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards (RWQCBs). The state of California is required under Clean Water Act (CWA) section 303(d) and federal regulations (40 CFR 130) to prepare a list of and set priorities for waterways requiring Total Maximum Daily Loads (TMDLs) because they do not meet water quality standards. The section 303(d) list was last revised in 2002. Federal regulations require the section 303(d) list to be updated every

Sources

- *California State University, Sacramento, University of California, Davis, and California Department of Transportation. "Caltrans Stormwater Management Program". Stormwater Journal. March/April 2001.*
- *California State Water Resources Control Board. Draft Statewide Urban Nonpoint Source Pollution Implementation Plan. 2003.*
- *City of Santa Monica, "Stormwater Best Management Practices for New Developments". Brochure.*
- *City of Santa Monica, "Working for a Cleaner Bay". Brochure.*
- *Dallman, Suzanne and Piechota, Thomas. "Stormwater: Asset not Liability". Los Angeles and San Gabriel Rivers Watershed Council. 2000.*
- *Gordon, Peter et al, "An Economic Impact Evaluation of Proposed Stormwater Treatment for Los Angeles County". University of Southern California. November 2002.*
- *Pitt, R. et al., "Potential Groundwater Contamination from Intentional and Nonintentional Stormwater Infiltration". US EPA, Office Research and Development, EPA/600/R-94-051*
- *United States Environmental Protection Agency, "Results of the Nationwide Urban Runoff Program – Final Report". US EPA Water Planning Division. 1983.*
- *United States Geological Survey, "Potential for Chemical Transport Beneath a Storm-Runoff Recharge*

two years. TMDLs represent the total pollutant load a waterway can assimilate before the waterway's beneficial uses are impacted. Nonpoint source runoff is frequently a significant source of pollutants in a waterway's total pollutant loading.

Because municipal governments are responsible for controlling urban runoff from streets and other public facilities within their jurisdictions, they are required to obtain an NPDES permit and implement specific measures to reduce the amount of pollutants in urban runoff. Permits for discharge to listed waterways having a TMDL must be consistent with the load assignments in a TMDL. Under California law TMDLs include implementation plans for meeting water quality standards. The implementation plans allow for time to implement control strategies to meet water quality standards. Under the initial NPDES permits issued in the 1990s municipalities were required to establish land use and development guidelines for both new and existing development to reduce the discharge of pollutants into waterways. These guidelines are usually a series of BMPs as described above. It has become clear with continued beach closures and other pollution problems associated with urban runoff that more advanced measures will be required in some areas to comply with water quality regulations.

Examples of nonpoint source pollution

- *Herbicides and insecticides from residential landscaped areas, golf courses, city parks, etc*
- *Oil, grease, and heavy metals illegally/ improperly disposed of or accumulated on parking lots, streets and highways from automobiles, trucks, and busses;*
- *Sediment from improperly managed construction activities*
- *Litter and green wastes*
- *Bacteria and nutrients from excess fertilizers, improperly maintained septic systems, and wastes from pets and wildlife.*

Benefits

Urban runoff management has the potential of generating multiple benefits. The primary benefits are to improve water quality and flood protection. In addition, in areas with the appropriate soil and geological conditions, it is possible increase water supplies by recharging groundwater with urban runoff. Groundwater recharge and stormwater retention facilities can be designed to provide additional benefits to wildlife habitat, parks, and open space. Underground infiltration galleries can temporarily store runoff and release it gradually to the aquifer while allowing the unimpaired use of the surfaces above them. For instance, a school campus can solve its flooding problem and develop a new sports field at the same time. These may provide secondary benefits to the local economy by creating more desirable communities to live in.

Statewide information on the benefits of increased management of urban runoff is not available. There are examples from local efforts. The Fresno-Clovis metropolitan area has built an extensive network of storm water retention basins that not only recharges over 70 percent of the annual storm water runoff (17,000 acre ft.) and removes a majority of conventional storm water pollutants, but recharges excess entitlement water (Sierra snow melt) during the late spring and summer (27,000 acre ft). Los Angeles County recharges on average 210,000 acre-feet storm runoff a year, which reduces the need for expensive imported water. Agencies in the Santa Ana Watershed recharge approximately 78,000 acre-feet of local storm runoff a year. The Los Angeles and San Gabriel Watershed Council has estimated that if 80 percent of the rainfall that falls on just a quarter of the urban area within the watershed (15 percent of the total watershed) was captured and reused, total runoff would be reduced by approximately 30 percent . That translates into a new supply of 132,000 acre-feet of water per year or enough to supply 800,000 people for a year.

The city of Santa Monica is an example of a municipality that is taking a watershed approach to managing urban runoff. Santa Monica's primary goal is to treat and reuse all urban runoff. If necessary, because of high runoff, the City's secondary goal is to release only treated runoff it to waterways. Both strategies improve water quality of the Santa Monica Bay. The first strategy turns a perceived waste product into a local water resource. Not only is water quality achieved, but a new water resource is harvested. The City's strategy promotes Low Impact Development and Smart Growth, two similar approaches to land use, in which urbanization works with nature and the hydrologic cycle, and away from the traditional pave it and move runoff as quickly as possible out of urbanized areas and into receiving water bodies. This approach decreases the dependence on imported water, leaving this water supply in distant watersheds for uses there, especially in the case of Southern California where most of its water comes from Northern California rivers, Eastern Sierra snow melt and Colorado River.

Costs

Information is not available on costs statewide to implement urban runoff management activities; however, the State Water Resources Control Board has recently contracted with the Office of Water Programs, California State University, Sacramento, to survey six communities to estimate the costs to municipalities to complying with their NPDES storm water permits. While this may address the cost of compliance for a municipality to comply with an NPDES permit, it may not be the most applicable for looking at watershed programs seeking multiple benefits.

An example from the city of Santa Monica illustrates the costs of the watershed approach to managing urban runoff. The city has a stormwater utility fee that generates about $1.2 million annually, and has been in place since 1996. These funds are used for various programs to reduce or treat runoff. These funds go to the Urban Runoff Management Coordinator, the maintenance of the storm drain system, and to help support other city staffs who perform supportive runoff work. Additional funds are spent by other divisions to support runoff management, such street sweeping, certain trash collection, and downtown pedestrian cleaning, and purchase and maintenance of equipment. The city has also received five grants totaling over $3.5 million for the installation of structural BMP systems, all of which will require long-term maintenance and monitoring by the city. The culmination of the city's program is the $12 million Santa Monica Urban Runoff Recycling Facility (SMURRF), a joint project of the cities of Santa Monica and Los Angeles. The SMURFF project is a state-of-the-art facility that treats dry weather runoff water before it reaches Santa Monica Bay. An average of 500,000 gallons per day of urban runoff generated in parts of the cities of Santa Monica and Los Angeles can be treated by conventional and advanced treatment systems at the SMURRF.

Major issues

Lack of Integration with other Resource Management Strategies - Solutions to managing urban runoff are closely tied to many interrelated resource management strategies. These include land use planning, watershed planning, water use efficiency, recycled water, protecting recharge areas, and conjunctive management. Because urban runoff occurs at a watershed level, so should the methods of managing urban runoff. A major problem is that land use planning is not conducted on a watershed wide basis. Many agencies currently spend millions of dollars annually on addressing urban runoff problems with very little interagency coordination even though downstream cities can be impacted by activities upstream. A watershed planning approach to manage urban runoff allows communities to pool economic resources and obtain broader benefits to water supply, flood control, water quality, open space, and the environment. Properly implementing this approach will require unconventional partnerships between different disciplines.

Lack of funding – The two main aspects of implementing urban runoff management measures are pollution control, including source control and education, and structural controls. In highly urbanized areas, major costs include purchasing land for facilities and constructing treatment facilities. Local municipalities have limited ability to pay for retrofitting existing developed areas within existing budgets and there is a concern by some about the economic impacts of raising taxes and requiring residents and businesses to pay for retrofitting existing development.

Effects of urban runoff on groundwater quality – Fate and transport of pollutants in urban runoff is a concern. Urban runoff may contain chemical constituents and pathogenic indicator organisms that could impair water quality. The actual threat to groundwater quality from recharging stormwater runoff is dependent on several factors including soil type, source control, pre-treatment, solubility of pollutants, maintenance of recharge basins, and depth to groundwater. Studies by USEPA (USEPA, 1983) and the U.S. Geological Survey (USGS, 1995) indicate that all monitored pollutants stayed within the first 16 centimeters of the soil in the recharge basins. One way to evaluate potential impacts to groundwater quality is to develop a monitoring program as part of a groundwater management plan with objectives for protecting both the available quantity and quality of groundwater.

Nuisance problems - Presence of standing water in recharge basins can lead to vector problems such as mosquitos. There is increasing concern related to mosquito formation and transmission of West Nile Virus. There are BMPs for managing these problems if applied diligently.

Protecting recharge areas – Local land use plans often do not recognize and protect groundwater recharge and discharge areas. Areas with soil and geologic conditions that allow groundwater recharge should be protected where appropriate.

Urban runoff education - There is a need to educate both the general public and elected officials about the linkage between land use management and other resource management strategies and how home and business practices can affect nonpoint source pollution in water ways.

Recommendations

- ■ The SWRCB and the California Coastal Commission in coordination with 26 other state agencies are finalizing the Five Year Implementation Plan for the Nonpoint Source Pollution Program, which includes management of urban runoff. The Implementation Plan recommends the following state actions:
- Promote coordination of interagency programs that protect water quality from urban runoff pollution.
- Reduce the potential for contamination of surface and groundwater that results from uncontrolled or poorly-controlled urban runoff practices.

- Develop tools to assess the effectiveness of urban water pollution programs.
- Increase the availability of regulatory and guidance documents and/or instructional workshops to demonstrate effective urban runoff pollution control programs and policies.
- Reduce the number of uncontrolled urban NPS pollution sources by increasing the number of municipalities, industries and construction sites that utilize NPS management measures and fit under the permitted State Storm Water Program.
- Develop and implement watershed-based plans, including TMDLs and Storm Water Pollution Prevention Plans (SWPPPs), in order to identify and address impacts from urban land use.

- ■ Encourage public outreach and education about the benefits and concerns related to funding and implementation of urban runoff measures.
- ■ Provide leadership in the integration of water management activities by assisting, guiding, and modeling watershed and urban runoff projects.
- ■ Work with local government agencies to evaluate and develop ways to improve existing codes and ordinances that currently stand as a barrier to implementing and funding urban runoff management.
- ■ Provide funding and develop legislation to support development of urban runoff and watershed management plans and enable local agencies and organizations to pursue joint venture, multi-purpose projects.
- ■ Assist agencies with developing recharge programs with appropriate measures to protect human health, the environment, and groundwater quality. To do this agencies should design recharge basins to minimize physical, chemical, or biological clogging, periodically excavate recharge basins when needed to maintain infiltration capacity, develop a groundwater management plan with objectives for protecting both the available quantity and quality of groundwater, and cooperate with vector control agencies to ensure the proper mosquito control mechanisms and maintenance practices are being followed.

When developing Urban Runoff Management Plans, agencies should

- ■ Understand how land use affects the urban runoff.

- Look for opportunities to require features that conserve, clean up, and reduce urban runoff in new development, or in more established areas, when redevelopment is proposed.
- Be aware of technological advances in products and programs that can assist.
- Learn about urban runoff / watershed ordinances already in place; learn from what others have already done and are doing. For example, The City of Santa Monica and the Fresno Metropolitan Flood Control District already have extensive urban runoff management programs in place.
- Integrate urban runoff management with other resource strategies including land use planning, watershed planning, water use efficiency, recycled water, protecting recharge areas, and conjunctive management, and coordinate both within and across municipal boundaries.

Urban water use efficiency

Urban water use efficiency efforts involve technological or behavioral improvements in indoor and outdoor residential, commercial, industrial and institutional water use that lower demand, lower per capita water use, and result in benefits to water supply, water quality, and/or the environment. In 2000, approximately (7 to 9.4 million acre feet, checking) of water was supplied to the urban sector. The range of net water savings of proven urban water use efficiency efforts by 2030 has been estimated to be 1,085,000 to 1,335,000 acre-feet per year (CALFED Record of Decision, 2000) with an annual cost of $xx to $yy and a total cost of $xx to $yy. In addition, a recent state sponsored study indicates potential savings from xx-xx acre-feet.

Current status

Californians have made great progress toward improved urban water use efficiency. The San Diego County Water Authority reports that their total consumption for 2003 is up less than one percent since 1990 with a population growth of 16 percent. Similarly, the Bay Area Water Agencies Coalition reports that population in their region has increased approximately 17 percent since 1986 with residential water use increasing by only 3 percent and their total water use actually decreasing by 1 percent. While some other regions of the state cannot claim such progress, these reports indicate that indeed something is working well in the field of water use efficiency. As has been demonstrated in various regions of the state, an increase in population does not necessarily result in a proportionate increase in urban water use.

Credit for this can be given in part to the implementation of water use efficiency practices that have been institutionalized through the California Urban Water Conservation Council's Memorandum of Understanding (MOU). This involves the active participation and united effort of urban water agencies, environmental interests, and the business community. They come together to plan, implement, and track a defined set of urban Best Management Practices (BMPs) including residential indoor and outdoor water use surveys and improvements; commercial, industrial, and institutional water use audits and plumbing retrofits, landscape irrigation audits and upgrades; district water system leak detection and repair programs; metering, washing machine incentive programs, conservation pricing, waste water reduction ordinances, and public information and education programs.

As of September 1, 2003, there were 309 signatories to the Urban MOU, representing 80 percent of all the urban water supplied in California. One example of the results of the CUWCC's member agency implementation efforts is that 2.3 million water efficient toilets have been retrofitted statewide in the past 12 years. The total number of toilets installed prior to 1992 that still need to be replaced is xx.

Water conservation has become a way of life for most Californians who have easy and affordable access to off-the-shelf water efficient plumbing fixtures, washing machines, landscape irrigation systems, and water thrifty plants at there local home improvement stores, hardware stores, and nurseries.

Benefits

The primary benefit of improving water use efficiency is the lowering of demand and the ability to cost-effectively stretch existing water supplies. Once viewed and invoked primarily as a temporary source of water supply in response to drought or emergency water shortage situations, water use efficiency and conservation approaches have become a viable long-term supply option, saving considerable capital and operating costs for utilities and consumers, avoiding environmental degradation, and creating multiple benefits for all sectors.

The financial benefits to agencies of water use efficiency are the avoided costs of new supply construction as well as the avoided costs of water supply treatment and wastewater treatment facility permitting, construction and operation. Energy costs, which are often much greater than water costs, are avoided as well, both by the agency and the customer.

The multiple benefits of urban water use efficiency include the positive impacts on water quality and water quantity in watercourses by allowing additional flows to remain in the environment. The timing of such additional flow is often critical to maintenance of endangered habitats. Water Use Efficiency can also reduce peak demand, green waste production, and urban dry weather runoff.

Potential costs

Overall, urban water use efficiency can be a very cost-effective strategy for new water supply. The cost of most of these measures ranges from ($29 to $700 per acre-foot, checking), depending upon the program (per CUWCC). These costs include not only the full cost to manage water conservation programs, but also any capital investments and staffing that may be required. In fact, water conservation measures that also include reductions in energy costs can produce a negative cost when those benefits to the agency and customer are considered. Water use efficiency programs can be cost-beneficial when implementation and management costs are less than the cost of implementing and managing the next increment of supply augmentation. However, where the cost of water supply is lower, an analysis should be undertaken to determine the overall statewide benefit should the conservation program be undertaken.

Major issues

The major issues related to improving urban water use efficiency in California are related to funding, program implementation, data collection, education and motivation, innovation, and dry year considerations.

Funding - Additional funding is needed for water use efficiency implementation projects as well as data gathering and analysis. Funds dedicated to Water Use Efficiency have fallen below commitments made in 2000 through the CALFED Record of Decision that called for a state and federal investment of $1.5 billion to $2 billion during Stage One from 2000-2007. State and federal agencies committed to funding 50 percent (25 percent each) with local agencies funding the remaining 50 percent of water use efficiency activities. To date, no evaluation has been made of local investments to meet ROD commitments.

ROD Expenditure Projections, including State, federal and local shares and Actual State and Federal Expenditures to Date (in $ millions)

Year	2001	2002	2003	2004	2005	2006	2007	Total
ROD Proj.	31	62	299	641	641	641	641	2,956
Actual Expend.	?	?	?	?	?	?	?	?

Table xx. ROD expenditure projections. This table can be found at the end of this section. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size table.

Presently, through the CUWCC MOU, local agencies have committed to funding locally cost effective BMPs. State and federal programs, on an erratic basis, provide a source of funding for the BMPs beyond the MOU level, for actions other than standard BMPs, and for those BMPs that may not be locally cost effective. Developing a consistent and broadly acceptable method to evaluate cost-effectiveness and water savings can be problematic.

While the initiative process has provided state bond funding for water use efficiency projects through Propositions 13 and 50, retaining a sufficient state and federal expertise to administer the programs and provide financial and technical assistance in this field is not easy with budget and staff cutbacks. Local agencies also face increasing challenges to implement water use efficiency actions with limited staff and budgets.

Grant programs often miss the opportunity to fund worthwhile projects in small and disadvantaged communities. It is often difficult for them to compete for limited grant funds, although their needs are often great. Also, investor-owned utilities have been ineligible for state funding for most programs.

Program Implementation - Even with the effective on-going efforts, much more can be done and needs to be done to implement effective water conservation programs. An expanding population, climatic uncertainties, and legal and economic conditions likely will increase the pressure to improve the efficiency of water use in California. Whereas, in the past, water conservation was seen as a short term response to drought conditions, present and future water use efficiency activities are now viewed as long term investments that, combined with other water management actions, make a significant contribution toward a sustainable water future for California.

The CUWCC Best Management Practices process has provided an effective way for agencies to identify and implement locally cost effective urban water conservation programs. But not all water suppliers have signed on to the agreement and those agencies that have signed on may not be fully implementing those practices. Further, while the Council is considering additional BMPs, there now are and in the future will be other activities could contribute toward improved water use efficiency including new methods and technologies that can be expected to significantly increase conservation potential.

Data collection - Documentation and evaluation of the achievements attributable to water use efficiency projects and programs, vital elements of successful water use efficiency efforts, need to be improved. The quantification of benefits for many projects lacks the necessary level of scientific rigor. The basis for making such determinations and managing water efficiently is accurate water measurement, coupled with volumetric billing, ongoing accounting, monitoring and assessment practices.

The measurement of water use and associated information provided to the water user is essential to efficient water management. Documenting water savings related to the various programs rests on the ability to track water use. Most urban areas are metered, but several metropolitan areas, mostly in the Central Valley and Foothill regions, remain unmetered. Approximately 700,000 water users remain unmetered.

Easily retrievable, standardized and comprehensive baseline data about California urban water use are not available. Present information sources include annual Public Water System Survey (PWSS) reports to DWR, annual CUWCC BMP Reports submitted by MOU signatories only, and Urban Water Management Plans that are updated every five years. Efforts are ongoing to standardize units of measurement for water use categories. Both of these endeavors are necessary to gain an accurate understanding of the full cost, value, impact and direction of urban water use efficiency strategies.

More information is needed about how Californians use water to help determine how scarce resources should be invested to maximize water savings and other benefits. How many acres of irrigated landscape? What is the breakdown between indoor and outdoor water use, between single family and multi-family residences?

Education and Motivation - Likewise, there is a need for information related to why Californians adopted water use efficiency practices and how those practices could be encouraged and sustained. Furthermore, we are not sure what types of incentives customers orwater districts respond best to, while we have seen evidence of a strong response to financial incentives whenever offered in a simple, understandable format and process. Which technological changes should be pursued for short-term situations (during water shortages) compared to long-term, and which behavioral changes are most effective short and long term?

Innovation - A more rapid response to new technologies and ideas should be pursued. Emerging water conservation technologies and techniques offer new opportunities to save water, but often field-testing and evaluations are needed before being promoted and adopted full scale. Presently it takes too long to run pilot projects, conduct research, and provide the sound scientific data needed by agencies and consumers to adopt new behaviors or purchase new equipment.

Dry-year considerations - Measures can and need to be taken now to prepare for dry years. As evidenced by the recent energy crisis in 2000, Californians respond admirably to calls for conservation during times of shortages. Under extraordinary circumstances, such as droughts, citizens are called upon to make changes in their normal water use patterns for a given period of time.

Water use efficiency can help stretch dry year supplies. By exercising water use efficiency practices during wetter years, more water can be stored in groundwater basins and surface water reservoirs for drier years, thus raising the threshold for needing extraordinary conservation efforts in dry times.

Demand hardening

Most water use efficiency programs rely on plumbing and appliance retrofits and changes in the consumer’s water use that can take place on a consistent, predictable basis. Once most of these retrofits have been completed, some worry that their ability to further reduce water use during dry years will be limited. This phenomenon is known as ‘demand hardening’. Districts and customers that have participated actively in water conservation programs fear that across-the-board cuts will affect them disproportionately. However, consumers will still respond behaviorally in drought times, and this additional water savings from the drought response can be measured. Public education has proven effective in rallying support for short-term additional water conservation measures.

Recommendations

The following actions reflect some of the possible solutions to the issues raised in the previous section. A wide range of strategies will need to be employed to accomplish the actions including financial incentives; revisions in state and local codes and standards; and legislative initiatives. Most of these will be cooperative efforts, involving state, federal, and local agencies as well as stakeholders and California citizens.

Fund water use efficiency projects

- Secure $XX of funding to support incentive programs, both implementation and data quantification, and associated expertise at the local level as well as at the state and federal levels.
- Identify and establish priorities for future grant programs and other incentives.
- Provide ample opportunities for small districts, economically disadvantaged communities, and investor owned utilities to benefit from WUE incentive programs.
- Work with tribes and community-based organizations to get the word out and assist in the development of proposals.
- Honor environmental justice policies established by funding agencies and others.

Expand implementation efforts

General

- Work with CUWCC and others to encourage and assist local agencies and governments in fully developing, implementing and sustaining water conservation programs.
- Develop and implement rate structures that encourage water use efficiency.
- Conduct distribution system audits, leak detection and repair on a regular basis to achieve less than xx percent losses, focusing first on the top ten percent of leaks.
- Assist water customers to perform leak detection and repair on a regular basis.
- Employ recycled water whenever feasible for landscape, industrial, and other approved uses.
- Encourage the plumbing of new construction for the use of non-potable water.

Urban landscape implementation efforts

- Create a "California Friendly Landscape." Irrigate landscapes efficiently at xx percent of ETo or less through landscape design, installation, management and maintenance practices including plant selection, irrigation scheduling, landscape audits, dedicated irrigation meters, weather driven timers, etc.
- Employ graywater systems where conditions permit.
- Employ cistern systems to capture storm water where appropriate.

Residential implementation efforts

- Work with builders, manufacturers and others to establish a "Water Star Homes" program for new and existing homes and performance standards for fixtures and appliances, reducing residential water use.
- Retrofit remaining standard toilets with more efficient models, such as dual-flush toilets.
- Replace standard clothes washers with high efficiency models.
- Employ hot water on demand systems in new residential construction.

Commercial, industrial, and institutional implementation efforts

- Pursue best available technology and management practices in the commercial, industrial, and institutional sector.
- Retrofit standard urinals with more efficient models.
- Conduct audits and provide incentives for retrofits.
- Encourage the formation of employee/management "Green Teams" in commercial, industrial and institutional customers to promote sustainable resource use.
- Encourage dry cooling for power plants.

Communication efforts

- Provide comprehensive public information, education, training, and technical assistance programs to foster a strong environmental resource ethic with an emphasis on water use efficiency.
- Coordinate with other resource management programs such as watershed management, urban runoff management, waste water treatment, and green waste reduction.

Gather required data: plan, research and monitor performance

1. Meter remaining urban customers and bill by volume of use,

submeter new multi-family residential construction, and submeter large landscape irrigation.

- Employ scientific methods to research, monitor, and evaluate existing and new water use efficiency technologies and management practices.
- Increase the emphasis on the science aspect of projects, especially monitoring and evaluation, in support of CALFED goals.
- Work with state and federal grant recipients and others to obtain more useful and consistent data from funded projects and other activities, including the documentation of the sources of data and the methods of data collection.

- Encourage comprehensive planning and implementation of water conservation activities at the local and regional level. Pursue and promote state or local policies, guidelines, ordinances, or regulations to affect positive change.
- Encourage additional signatories to the CUWCC Memorandum of Understanding and full participation by present signatories.
- With the leadership of the CUWCC and participation of other stakeholders, standardize utility billing and reporting systems by customer type and units of measure and identify industrial water use customers by North American Industry Classification System (NAICS). Collect end-use data periodically. Coordination of water use reports and the use of a web-based format for reporting could also improve data collection and exchange. Amend the Urban Water Management Planning Act to require uniform water use reporting.
- Gain more information through surveys and other methods to better understand how Californians use water and how to persuade them to adopt more efficient practices and behaviors. Establish a goal for per capita water use in California.

Educate and motivate

- Develop community based social marketing surveys and strategies for conservation activities to foster water use efficiency, with the participation of the water industry, environmental interests, and the business communities.
- Identify and overcome barriers, communicate the benefits, provide incentives, and gain commitment from all involved.

Innovate

- Explore and identify innovative technologies and techniques to improve water use efficiency and develop new BMPs to correspond with new information.
- Fast track pilot projects, demonstrations, and model programs exploring state-of-the-art water saving technologies and procedures and publicize results widely.

Prepare for dry years

- Have a comprehensive campaign ready to go for the next drought.
- Conduct contingency planning for extraordinary short- and long-term shortages.
- Determine a “drought per capita” potential.

ROD Expenditure Projections, including State, federal and local shares and Actual State and Federal Expenditures to Date (in $ millions)

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Actual Expend.	?	?	?	?	?	?	?	?

Water dependent recreation

Water-dependent recreation includes a wide variety of outdoor activities that can be divided into three categories. The first category is fishing, boating, swimming, rafting and other activities that can only occur on water surfaces such as fresh-water lakes, reservoirs, and rivers. Next are turf-related activities, such as golf, that do not require a water surface but are very much dependent on water for irrigation. The last category is activities that are not truly dependent on water but do enjoy the aesthetic benefits afforded by nearby water surfaces. These activities are often nature-based and include wildlife viewing, picnicking, camping and hiking.

Current status

California is an outdoor state and water is a magnet for outdoor recreation. As shown in the adjoining graph, a 1997 survey confirmed that most Californians participate in some form of water-dependent recreation. In 1997, about 100 million visitor-days were spent participating in recreation activities that are directly dependent on water. Many more visitor-days were spent in nature-based activities such as wildlife viewing (120 million days) and hiking (79 million days). More than 177 million visitor-days were also spent participating in activities that require irrigated turf. In addition, water-dependant activities and experiences are a large draw to tourists, with an estimated 28 million visitors in 2001. It is not surprising, therefore, that many of the popular outdoor recreation activities are dependent on or enhanced by water resources.

Most Californians also agree that more water-dependent recreational facilities are needed. For example, in a 2002 survey of California's residents, more than 80 percent of the respondents either moderately or strongly agreed that more outdoor recreation facilities are needed at lakes and reservoirs.

Benefits from water-dependent recreation

Water-dependent recreation provides a wide range of health, social and economic benefits to California residents and visitors, while improving the quality of life. It encourages physical activity, such as swimming and paddling as well as walking and bicycling along attractive waterside trails.

Water-dependent recreation influences tourism, business and residential choices. It increases expenditures in the community for travel, food and accommodations. In 2001, California had 28 million out-of-state

Sources

- *Multiple reports issued by the U.S. Army Corps of Engineers*
- *Department of Fish and Game, License and Revenue Branch*
- *Public Research Institute, "Survey of Boat Owners in California"*
- *Reports accessed at the Department of Parks and Recreation, Planning Division Library*
- *Department of Parks and Recreation, "Public Opinions and Attitudes on Outdoor Recreation in California 1997 (2002)", www.parks.ca.gov*
- *Department of Parks and Recreation, "California Outdoor Recreation Plan 2002", www.parks.ca.gov*
- *American Sportfishing Association, www.asafishing.org*
- *California Department of Tourism, www.gocalif.ca.gov*
- *State Board of Forestry., California Department of Forestry and Fire Protection. "The California Fire Plan", www.fire.ca.gov*

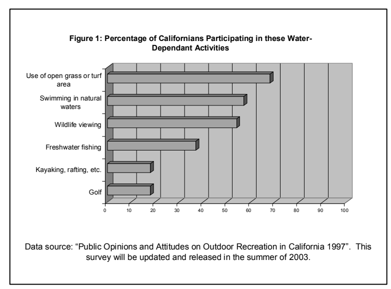
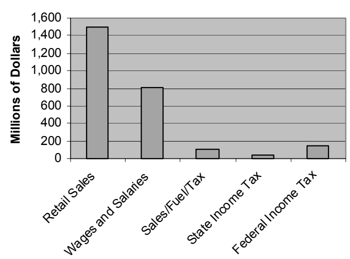


Figure x Percentage of Californians participating in these water dependent activities

tourists spending an average of $76 a day and staying an average of four days. In addition, 196 million resident tourists spent an average of $70 a day. Sales of sportfishing licenses and stamps generated more than $48 million in annual revenue for the Department of Fish and Game in 2000 and 2001. Water-dependent recreation prompts long term investments while creating jobs in concessions, hotels, restaurants, and retail stores.

Figure 2: 2001 Economic Impact of Freshwater Fishing in California (2,206,382 Licensed Anglers)



Potential costs

Initial development costs of recreation facilities can vary with the size of the project. Generally 3 percent to 6 percent of total project costs are allocated for development of permanent recreation facilities. For example, the capital cost of recreation facilities located on the State Water Project is about 3% of all capital expenditures for the SWP. For development of interim public use facilities at a project site, a minimum of $500,000 should be allocated. Ongoing maintenance costs can range from 5 percent to nearly 80 percent of initial development costs of recreation facilities, depending on the size and scope of the facilities.

Major issues

The major issues facing the provision of increased and improved water-dependent recreation opportunities in California are:

Funding – Funding concerns usually transcend all other issues affecting outdoor recreation facilities, including those for water-dependent recreation. Maintenance of recreational facilities may be more susceptible to funding cuts during poor economic conditions than for other resources thought to be more essential. Instability of funding can reduce the effectiveness of recreation providers to deliver quality, consistent and relevant facilities and services to meet growing demand. Many park and recreation providers have taken steps to reduce programs and operating costs to become more efficient on leaner budgets by raising fees and charges, reducing or eliminating services, delaying equipment purchases, and deferring land acquisition, facility developments, rehabilitation and renovation of aging infrastructure. Inconsistent funding also makes it difficult to plan for stable services and reduces the willingness of many service providers to offer new programs or to take risks.

Impacts to Natural Resources – Natural resource values often define the character and aesthetic appeal of a water-dependent recreation area, making it desirable and interesting to visitors. Overuse, misuse and poorly planned uses of any recreation resource can have a significant impact on natural resource values and on the experiences of those wishing to enjoy them. Increasing numbers of visitors pursuing outdoor recreation activities threatens the proper functioning of ecosystems, disrupts and displaces wildlife and degrades the natural, environmental and aesthetic quality of an area and ultimately the very recreational experience being sought. In addition, visitors unfamiliar with ecological processes or environmental ethics are often unaware of the consequences of their actions.

Water Quality – Poor water quality can have a negative impact on water-dependent recreation in California. Contaminated lakes, rivers and streams not only may present health risks to those participating in water-contact recreation, but they can significantly diminish the recreation experience. One source of contamination is untreated sewage escaping from treatment facilities or broken sewer lines which have led to the highly publicized closure of public beaches. Untreated sewage discharged from houseboats and other pleasure craft is another source of pollution that has been a significant problem in the Sacramento-San Joaquin Delta. Fertilizers and chemicals from agricultural runoff also contribute to the problem.

Coordination – Funding and impacts to natural resources are exacerbated by the lack of coordination between those who manage water resources and those who provide recreational services. All too often, agencies are limited in scope and effectiveness in recognizing and mitigating trends affecting resource conditions, particularly outside their immediate jurisdiction. While partnerships and cooperation between agencies, organizations and individuals have grown, efforts at the watershed or landscape level are often fragmented, and opportunities are missed to achieve broader goals, placing both resources and the public at risk.

Recommendations

- In developing water-dependent recreation opportunities, jurisdictions should consider public needs as identified in the California Outdoor Recreation Plan.
- Increase public awareness about water-dependent recreation opportunities, impacts to natural resources, and the importance to support funding of said opportunities by implementing and encouraging research exploring latent demand, social and economic values of water-dependent recreation.
- Support development of a statewide inventory of water-dependent recreation resources including nature-based activities, with projec-

tions for future recreation needs.

- Conduct, and periodically reexamine, scientifically valid studies of the carrying capacity of proposed and existing sites for water-dependent recreation to help prevent degradation of water quality and wildlife habitat.
- Collect data on visitation rates vs. water levels at project sites and use this data to reassess site operations to help optimize recreation opportunities by creating a balance to meet the needs of different activities, both at reservoirs and downstream.
- Develop partnerships with universities to coordinate the monitoring of public recreation use, equipment and emerging outdoor and water-dependent recreation trends.
- Promote and establish effective partnerships between federal agencies, state and local governments, and the private sector for management of water-dependent recreation facilities.
- Use data collected by other agencies, such as the U.S. Bureau of Reclamation, U.S. Army Corps of Engineers and for the Federal Energy Regulatory Commission (such as the results of FERC Relicensing studies) to facilitate the implementation of Recommendations 4 through 7.
- Create partnerships with education providers to educate youth about preserving and protecting natural resources.

Watershed management

Watershed management is the process of evaluating, planning, restoring and managing land, water and other resource use within a watershed to provide desired goods and services while maintaining a sustainable ecosystem. Watershed management protects the public trust, preserves ecological functions and processes, provides for safe and healthy communities and is viewed from a geographic scale that reflects watershed or drainage boundaries.

Watershed planning (the planning and evaluation components of watershed management) is described in greater detail in Chapter 4 as a key example of how to develop integrated resource management plans at a regional level. This section focuses on how watershed management can help planners: 1) identify and incorporate ecological functions and processes into projects, 2) connect the ongoing behavior and functions of projects to other things that are going on in the watershed, and 3) satisfy the social and economic interests of the communities affected by the projects. It also describes why considering these attributes concurrently while developing the project plan, will provide for a more sustainable outcome than if they are considered separately or not at all.

Watershed management is also marked by stewardship and a process of interaction that invites interested parties to participate, is respectful and tolerant of diverse views, and seeks to satisfy many needs of the participating community and the people that various interests represent. The process provides a chance to balance diverse goals and uses for environmental resources, and to consider how cumulative actions may affect long-term sustainability of these resources.

Current status

NOTE: Need to add text here to give examples of successful watershed projects and best management practices.

Benefits of watershed management

Enduring value - The most dramatic benefit of watershed management is its ability to generate enduring value from the integration of ecology and community interests. The melding of interests reduces or eliminates competition for resources, provides satisfying outcomes to a large number of people, and yields cost effective solutions. Social tension around projects is replaced with broad ongoing support. Looking at the ecological dynamics from a watershed scale captures most if not all important processes and functions. Projects that are designed with this ecological scale in mind have a low risk of being undermined by natural events. Projects incorporating ecological conditions also preserve and enhance ecological conditions for future generations. Combining these features creates strong desires to maintain projects and continue to reap their benefits.

Communication and collaboration - At the heart of the most successful approaches is an effort to communicate the underlying interests of those involved, and to avoid a focus on competing positions at least until the interests are well understood. By describing interests behind programs, regulations, and personal positions, people are able to combine and integrate their work. Through this interest based approach, a stewardship ethic often emerges that serves to guide management. Communicating what is important to people creates opportunities for those who engage in the process to find strong allies throughout their community. The complexity of our communities and the ecological settings we live in mean that no one entity is capable of fully managing a watershed or even significant multi-benefit projects. Projects designed for watershed management typically involve the collaboration of networks of people in both the public and private sectors.

Preserving ecological functions and processes - Watershed management helps preserve ecological functions and processes by helping us consider natural cycles (hydrologic, nutrient, and life cycles) when designing projects. For example, promoting groundwater accretion to streams and riparian cover often cools stream temperatures. Designing projects to allow more water to soak into the ground, less water to sheet off as runoff, to protect the soil surface from erosion by planting native plants, and to stabilize stream channels and swales (with vegetation and fluvial geomorphic characteristics) brings the project more in line with the natural water cycle.

We can also design projects with an eye towards the native precipitation patterns and the relationships between native vegetation and the hydrologic cycle. Many native plants have deep rooting patterns that help water soak deep into the ground. Plants also reduce the impact of falling rain and the energy of flowing water, so that soil and hillsides are more stable and absorb more water than if left bare or covered with shallow rooting plants. Native plants also exhibit cycles of water use (transpiration) that match precipitation patterns. The temperature of waters also becomes an important ecological consideration and many of our water courses suffer from elevated water temperatures.

Another important natural cycle is the nutrient cycle. By considering the watershed, projects can be designed and built to support local nutrient cycling, to minimize the amounts of nutrients needed in the landscape, and to promote a balance of nutrients that fit within the native ecology. For example, ornamental landscapes can utilize more native plants which require little or no fertilization. Increases in the density of housing and other buildings can allow for greenbelts and river parkways that can be repositories for compost. Local greenwaste can become a resource rather than a waste. Similar to how stormwater flows can be attenuated by improving runoff, nutrient loading can be attenuated by diminishing the use of rapid release fertilizers and building features that demand local cycling of nutrients. Using wetlands in water pollution control is an example of this approach.

Life cycles and migration patterns of animals is another set of important cycles to consider. Watershed Management seeks to actively restore these critical habitats to bring some balance back into the landscape for these essential features. We need to think beyond setting aside special habitats. Building these ecological features into our everyday operating procedures is crucial to sustaining these features. Working at the watershed scale provides greater opportunities to build projects that support the natural relationship of habitat and sustainable plant and animal communities. For example, we currently manage many dams to create a cold water habitat in historically warm water settings on the valley floor in order to support endanger populations of anadromous fish. Finding ways to get fish above the dams to spawn in their natural spawning reaches could bring a better ecological balance to dam operation.

Connecting to other things in the watershed - Watershed management helps identify important aspects of each setting that define the working ecology. One practical approach is to identify specific influences of the project within the watershed but that fall outside the immediate project area. Preserving and restoring riparian and stream channel functions is one place where a broad array of ecological needs come together and can be supported in a relatively small area. By creating ribbons of habitat flanking each stream course a tremendous improvement in a host of ecological processes would be attained.

To sustain these complex systems requires managing the upslope areas as well. In urban areas, an upslope feature that is largely ignored is the roof top. Redesigning roofs to fit the cycles and functions important in a watershed could transform the landscape. In agricultural areas, people are working at vegetating canals and ditches putting in tailwater ponds and other means to expand the ecological characteristics of their lands.

Satisfying social and economic interests -The way people interact is a key component of watershed management. All projects, large or small, are designed to reap multiple benefits and fit within the local ecology. Watersheds are medium to large scale areas. So the need to involve a large number of people becomes compelling. In recent years a number of techniques for seeking input from large groups of people have been applied to resource management in general and watershed management specifically. In many cases we have constructed water systems that no longer adhere to natural drainage patterns. So to an extent, watershed boundaries and the ability to integrate projects are operationally defined. The boundaries that define the watershed bring together project proponents, often with very different backgrounds and ideas. Participation on a watershed management or stewardship group can give people a safe and open forum to express their ideas. In many cases the first efforts are modest ones that are needed to cement the operating relations among members of the group. As greater understanding, confidence and trust emerge the projects grow in scale and complexity.

Costs associated with watershed management

Redirecting usual costs - Currently costs are incurred for measuring various features in the environment, planning projects, and building the projects. Incorporating ecological functions into projects represents a different perspective, but not necessarily added costs. For example, some nurseries in Southern California have found that by growing plants in the peripheral drainage ditches of their properties they are able to reduce nutrient discharges and wastewater while growing a saleable crop. In agricultural setting tailwater ponds and vegetated canal systems have replace disking and spraying field edges and canals banks. Providing stream systems access to their flood planes has reduced the potential damage from levee failures and lowered maintenance costs.

New Costs - Discrete new costs for watershed management that are above and beyond the redirected costs have not been estimated.

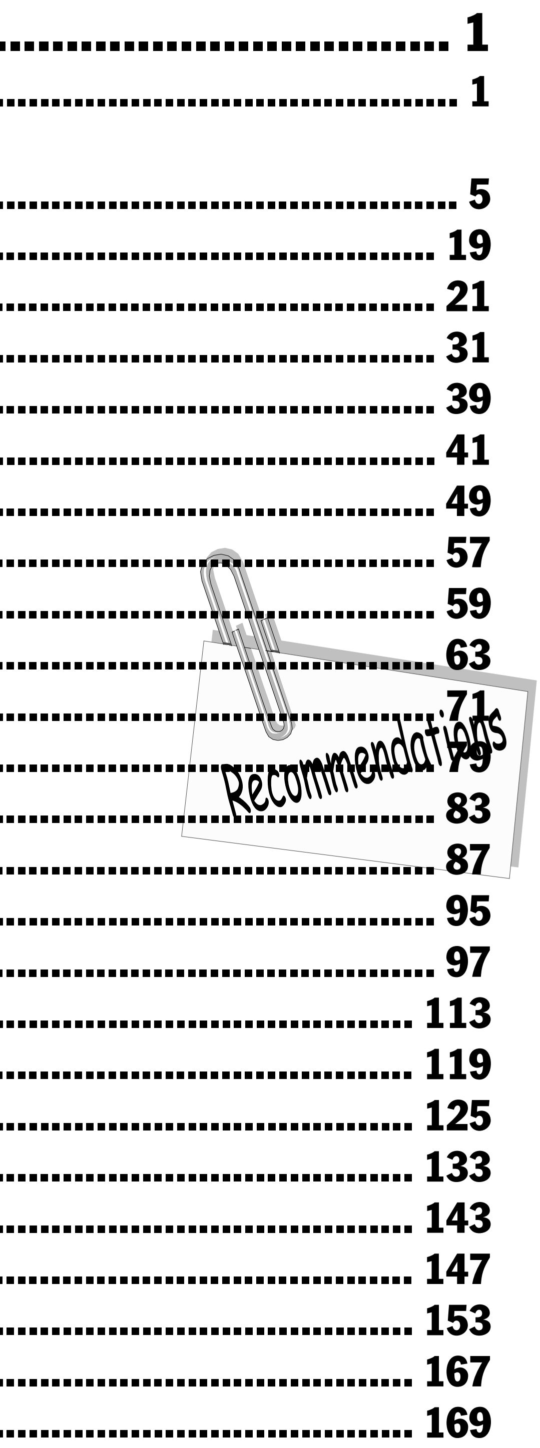
Major issues

Land uses alter hydrologic cycles - The hydrologic cycle includes precipitation as snow or rain, the flow of water over and through the land, and the evaporation of water back into the atmosphere. We can see that how we use the land has caused a reduction in rainwater infiltration and increased the volumes of stormwater runoff. Storms, especially in urban areas but also in many agricultural areas are now marked by high intensity runoff over short periods of time. This creates greater flood risk and reduces the ability to capture water for our needs during dry times. From an ecological perspective, this compression of runoff events robs the streams and landscape of ground water. This leads to drying of the land, a shift in vegetation types, lower and warmer streams, deterioration of stream channels, all of which leads to shifts in the plants and animals that can be supported.

Human activities alter nutrient cycles - Another important natural cycle is the nutrient cycle. As we develop our watersheds we tend to increase the amount of water soluble nutrients, often concentrating them in fertilizers or biosolids. These concentrated forms of nutrients can trigger dramatic changes in water bodies, vegetation, and animal communities. Many native plants evolved under fairly low nutrient conditions. Increasing the available nutrients often leads allows invasive plants to overrun the native vegetation. This can reduce the infiltration capacity of the land and diminish the habitat quality. We also see that we often export nutrients from the location that they are generated. In some cases this is through the pollution of water which carries the nutrients to a point where they can support algae or other plant growth that impairs the water. In other cases this is through sewage or biosolid transport. In any case, the result is an increase in nutrient loads that often diminish the ecological quality where they come to rest.

Project implementation disrupt habitats and migration corridors - Life cycles and migration patterns of animals is another set of important cycles to consider. Many projects built in the past have unthinkingly disrupted migration corridors or destroyed or impoverished habitat that is critical for certain life stages of animals. Coastal wetlands that support breeding, nursery and rearing habitat for many ocean species have been particularly hard hit. Dams have blocked access to spawning and rearing habitats for anadromous fish. Riparian forests that support migration of South American birds, and inland wetlands that support the Pacific Flyway species have all been severally impacted.

Fairness, inclusion, and decision making - Because many watershed projects are collaborative in nature, projects often require coalitions of parties to successfully implement them. The governance structures for these groups are not standardized. They range from ad-hoc groups, to formal delegations of authority. The interest based discussion often takes a



significant amount of time. All interested people do not have the same ability to stay involved and therefore issues of fairness and inclusiveness in the decisions about projects can arise.

Science and understanding -There is not a readily available source for finding key ecological information that can be incorporated into projects. Scientific assessments seek to provide a good technical description of watershed conditions, but cannot be definitive. State agencies can assist in describing important ecological processes and functions throughout the state. As watershed assessment matures, a better understanding will likely emerge and more localized information will become available. Integrating ecological processes into project design, construction, and operations and maintenance will continue to be an evolving process.

Recommendations

- Design projects with ecological processes in mind and with a goal of making the projects as representative of the local ecology as possible.
- Place projects in the watershed in a way that allows them to reinforce each other and build on the impacts collectively to support the local ecological cycles.
- Increase the ability for precipitation to infiltrate into the ground, reduce surface runoff to a point where it reflects a natural pattern of runoff.
- Restore and preserve stream channel morphology to allow access of flood waters to the flood plane and to provide for stable banks and channel form.
- Create ribbons of habitat around stream and river corridors and provide as much upslope compatibility with these corridors as possible.
- Rely on native plant communities where ever feasible.
- Incorporate nutrient cycles that rely on the local watershed to supply and receive nutrients for important processes in the watershed. Consider nutrients as resources not wastes.
- Preserve features that support migration corridors or critical life stage habitats.

Water transfers

Water transfers are defined as a temporary or long term change in the point of diversion, place of use, or purpose of use due to a transfer or exchange of water or water rights (see footnote). Transfers can be from one party with a little extra water in one year to another who is water short that year, and transfers can be between water districts that are neighboring or across the state, provided there is a means to convey the water. Water transfers can be a temporary or permanent sale of a water right by the water right holder; a lease of the right to use water from the water right holder; or a sale or lease of a contractual right to water supply. Water transfers can also take the form of long-term contracts contingent on drought conditions. Transferable water comes from four major sources:

Releasing additional water from storage in reservoirs beyond normal operations. Normal operations include releases to meet scheduled deliveries, environmental needs, flood control, etc.

Pumping local groundwater in lieu of using historically used surface water rights and transferring the surface water rights.

Transferring previously banked groundwater either by directly pumping and transferring groundwater or by pumping groundwater for local use and transferring surface water rights.

Reducing the existing consumptive use of crops through crop idling or crop shifting to make water available for transfer.

Water transfers are sometimes seen as merely moving water from one beneficial use to another. However, in practice water transfers become a form of flexible system reoperation linked to many other water management strategies including surface water and groundwater storage, conjunctive management, conveyance efficiency, water use efficiency, water quality improvements, and planned crop shifting or crop idling. These linkages to other water management strategies, often result in increased beneficial use and reuse of water overall. One of the most valuable aspects of water transfers can be this flexibility to take advantage of different water management strategies and foster cooperation among water agencies. For example, water transfers can encourage water agencies to more aggressively implement conjunctive management projects either alone or in cooperation with other agencies to increase local supplies and sell surplus water. Transfers also provide a flexible approach to allocating available supplies for environmental purposes.

Footnote

Temporary water transfers are defined in Section 1728 of the California Water Code as any change of point of diversion, place of use, or purpose of use involving a transfer or exchange of water or water rights for a period of one year or less. Long term water transfers are defined in Section 1735 of the California Water Code as a transfer of water or water rights involving a change of point of diversion, place of use, or purpose of use for any period in excess of one year.

Sources

- *CALFED. Water Transfer Program Plan. July 2000*
- *CALFED. Programmatic Record of Decision. August 29, 2000.*
- *DWR. Water Transfer Papers for Water Transfers in 2002 Involving the Department of Water Resources (Draft 3-8-02) (www.watertransfers.water.ca.gov)*
- *DWR. Draft EIR/S for the Environmental Water Account. 2003 (release pending).*
- *Governor's Advisory Drought Planning Panel. Critical Water Shortage Contingency Plan. December 29, 2000.*
- *Hanak, Ellen, "Who Should Be Allowed to Sell Water In California? Third-Party Issues and the Water Market". Public Policy Institute of California. San Francisco, CA, June 2003.*
- *Jenkins, M.W., et al, "Improving California Water Management: Optimizing Value and Flexibility," University of California, Davis, CA, http://cee.engr.ucdavis.edu/faculty/lund/CALVIN/, 2001.*
- *Newlin, B.D., M.W. Jenkins, J.R. Lund, and R.E. Howitt, "Southern California Water Markets: Potential and Limitations," Journal of Water Resources Planning and Management, ASCE, Vol. 128, No. 1, pp. 21-32, January/February 2002.SWRCB. A Guide to Water Transfers (DRAFT). July 1999.*
- *SWRCB. "Water Transfer Issues in California: Final Report to the California State Water Resources Control Board by the Water Transfer Workgroup". June 2002.*

Data in this section

Data in this section are drawn from chapter 2 and appendix A of Ellen Hanak, Who Should Be Allowed to Sell Water in California? Third-Party Issues and the Water Market*, Public Policy Institute of California, 2003 (available for download at www.ppic.org). These data do not include transfers between farmers within the same water district, which can be substantial in some places.*

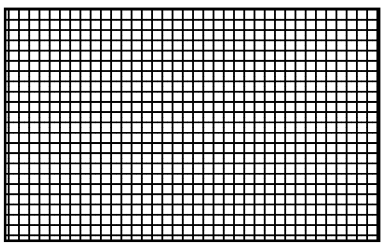


Table xx. Placeholder for Temporary water transfers in California since 1985. This graph would be found at the end of this narrative. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size graph.

Current status

Statewide, water transfers have increased since the mid-1980s. Temporary transfers between water districts rose from 80,000 acre-feet in 1985 to over 1,250,000 acre-feet in 2001 (see figure 1). About 80 percent of this volume is traded on a short-term basis, within the same year. The remaining 20 percent is considered “long-term”, for durations ranging from two to 35 years. Since 1998, there have been several permanent transfers of water rights and contracts with the Central Valley Project and the State Water Project for up to 175,000 acre-feet per year.

Statewide water conditions have encouraged water transfers as a management strategy. Transfer activity increased substantially during the drought of the late 1980s and early 1990s, especially through the state-run Drought Water Bank and other drought-related state and federal programs. Purchases continued to increase since the mid 1990s, generally a much wetter period, suggesting that water users may have become more accustomed to using water transfers.

Throughout this period, agricultural water districts have been the primary source of water supply, although in some wet years urban districts in Southern California have also transferred water to other users. The pattern of purchases has changed somewhat between the prolonged drought in the early 1990s and the more recent period (Figure 2). Although urban water districts were a primary destination in the early 1990s, accounting for over 40 percent of all purchases, their purchases have remained flat since the mid 1990s and now account for only 20 percent of all purchases.

Two sectors responsible for most growth in transfers have been environmental programs and agriculture. Environmental purchases to benefit wildlife refuges and instream fish populations began during the early 1990s drought. They have increased considerably under the Central Valley Project Improvement Act and CALFED’s Environmental Water Account, accounting for roughly 25 percent of the total since 1995 and as much as one-third by 2001. Agricultural districts now account for half of all purchases, and have been responsible for two-thirds of growth in transfers since 1995.

The bulk of this increase is destined for farmers in the San Joaquin Valley and Tulare Basin, who have turned to transfers for replacement water in response to cutbacks of contract allocations under the Central Valley Project Improvement Act. Typically, farmers purchase water on a year-to-year basis. Most long-term and permanent transfers are destined for urban users.

Three regions are major participants in water transfers: the 10-county Sacramento Valley, the 8-county San Joaquin Valley and Tulare Basin, and the 7-county Southern California region (see Footnote: data availability). In most years, roughly 75 percent of transfers originate within the Sacramento and San Joaquin Valleys, with the remainder from Southern California. Overall, most transfers are between users within the same county (nearly 25 percent) or within the same region (nearly 50 percent). Interregional transfers account for the remaining 25-30 percent of transfers. Only a 20 percent of these transfers are negotiated directly between parties in different regions; the rest move through programs run by DWR and USBR.

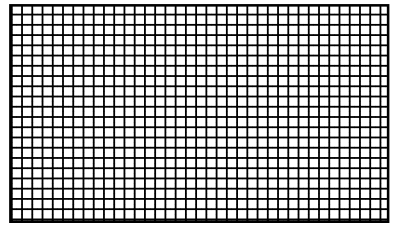


Table xx. Placeholder for Water Transfers by Type of End-user. This graph would be found at the end of this narrative. In a digital version of the Update, this thumbnail will be linked and clickable to the full-size graph.

Current oversight

Before the Drought Water Bank program, water transfers were usually arrangements between two parties, one with surplus water supply and one in need of additional water. These parties would reach a mutually acceptable arrangement regarding price and quantity. Because public rights in water have always been recognized, approval by appropriate state and federal agencies has been viewed as a necessary part of the process for these independent water transfers. State water law requires that transfers not injure any other legal user of water, not unreasonably affect fish and wildlife, and not unreasonably affect the overall economy of the county from which the water is transferred (see Footnote: Water Code).

The dry year programs, Environmental Water Account (EWA), and Central Valley Project Improvement Act have increased the role and responsibilities of the state and federal agencies in the water transfer process. A large portion of water transfers each year now occur either under the guidance of, or funded by, a state or federal program. The complexity of cross-Delta transfers and the need to optimize the use of both CVP and SWP facilities, make USBR and DWR critical players in the water transfer process. The rules that govern water transfers within the SWP or CVP typically protect water users within these projects from the potential adverse effects of water transfers made by other project users.

The EWA is a program element of CALFED's Water Management Strategy for the Bay-Delta Ecosystem that is administered, managed, and implemented by five federal and state agencies (U.S. Bureau of Reclamation, California Department of Water Resources, U.S. Fish and Wildlife Service, National Oceanographic and Atmospheric Administration Fisheries, and California Department of Fish and Game). USBR and DWR, as the

Footnote: data availability

Data availability restricts regional definitions to county groupings, not DWR's hydrologic regions. Notably, Southern California includes both the South Coast and Colorado River hydrologic regions (Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties), and the San Joaquin Valley includes both the San Joaquin River and Tulare Lake hydrologic regions (Fresno, Kings, Kern, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties). Sacramento Valley counties include Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Sutter, Tehama, Yolo, and Yuba.

Footnote: Water code

California Water Code Section 1810 et seq. *specifies the requirements that must be met in order for DWR and other regional and local agencies to allow use of their conveyance facilities. Also, Water Code Sections 386, 1702, 1706, 1727 and 1736 follow the common law and establish similar requirements for changes in water rights. Strictly speaking, economic issues are typically only required to be evaluated in water transfers that seek to utilize DWR's water conveyance facilities or those of other State or local agencies. However, economic impacts that are associated with physical changes to the environment may require analysis under the California Environmental Quality Act (CEQA).*

EWA Project Agencies, are the key agencies with respect to overseeing and facilitating water transfers in the state. EWA water is replacement water for water that was not delivered to CVP and SWP contractors in the export service areas during prior pumping curtailments that were required to protect at-risk fish species in the Delta.

Enactment of the Central Valley Project Improvement Act (CVPIA) in October 1992, provided new authority and expanded flexibility to Reclamation to assist California water users in meeting their water needs through transfers of federally developed water. One of the purposes of the CVPIA is to improve the operational flexibility of the CVP and to increase water-related benefits provided by the CVP to the state through expanded use of voluntary water transfers. The water transfer provisions of the CVPIA govern the transfer of CVP water and authorizes all individuals or districts who receive CVP water under water service or repayment contracts, water right settlement or exchange contracts to transfers, subject to certain conditions, all or a portion of the water subject to such contracts to any California water user or agency, state or federal agency, Indian Tribe or private nonprofit organization for any purpose recognized as beneficial under state law.

Controversy regarding the effects on water users, fish and wildlife, and local economies strained the Drought Water Banks of the early 1990s. In response, DWR and USBR have developed guidelines for the implementation of water transfers conducted within their areas of responsibility. The purpose of the guidelines is to resolve issues where possible, and make clearer the technical aspects of water transfers that need consideration when contracting with these agencies to either sell or convey water made available through water transfers. DWR has published its guidelines, which can be found in a series of white papers available on DWR's Water Transfers Office web site (http://www.watertransfers.water.ca.gov). Reclamation, upon enactment of CVPIA, issued "Interim Guidelines for the Implementation of the Water Transfer Provisions of Central Valley Project Improvement Act." These Interim Guidelines, as revised and/or updated, establish the conditions for the transfer of Project water as authorized by CVPIA. Copies of these Guidelines can be obtained from Reclamation's Water Transfer Program office.

In addition, DWR and water districts in Northern California have begun to develop better mechanisms to deal with the needs of local water users and the environment. Cooperative monitoring and rapid response programs were implemented to identify and protect or mitigate potential impacts on groundwater levels from groundwater substitution programs.

Data from monitoring programs and open communication with parties that could be affected helped identify groundwater issues as they developed and before adverse impacts became serious. Districts took actions to halt pumping, deepen wells, and work with parties that could be affected in order to prevent or mitigate impacts caused by water transfers.

Local leadership and initiative are also needed to effectively implement water transfers. Water transfers are typically proposed by local water agencies that could benefit from involvement of the local community in the development of these proposals. Some counties have passed local ordinances to regulate groundwater extraction for water transfer purposes. With adequate public notice, disclosure of proposals and meaningful public participation, local communities can best assess their area's need for water supplies and determine if there is a potential for transferring water outside of the local region.

Potential benefits

Water transfers have the potential of reducing economic disruption, maintaining community stability, and improving environmental conditions in receiving areas caused by water scarcity in return for providing economic compensation to sellers. Sellers can use this compensation to fund a number of beneficial activities, although there is no guarantee that the benefits to the seller will benefit the source area as a whole. Water districts can use the income to improve their facilities, which may have statewide benefits. For example, Western Canal Water District used proceeds from drought water bank sales to remove diversion dams and reconfigure its canals to reduce impacts on threatened spring-run salmon. Farmers can reinvest back into the farming business. Transfers by regional water agencies can provide additional resources to benefit the entire community. For example, the Yuba County Water Agency has used over $10 million from the proceeds of water transfers over the past several years to fund badly needed flood control projects for the county.

In addition to the approximate 1.2 MAF transferred in recent years, economic studies (see Footnote: Draft EIR/EIS) indicate that about 300 TAF in the Sacramento Valley and 400 TAF in the San Joaquin Valley could be made available by through crop idling without unreasonably affecting the overall economy of the county from which the water would be transferred. These studies estimate that the economic effects of idling up to 20 percent of the rice land in the Sacramento Valley and up to 20 percent of the cotton lands in the San Joaquin Valley in any given year are near 1 percent

Footnote: Draft EIR/EIS

Studies conducted for the Public Draft EIR/EIS for the Environmental Water Account dated July, 2003 or less of the county-wide economy except in Glenn and Colusa counties where the impact would be less than 5 percent of the county-wide economy. The amount of land that would be idled is about 300,000 acres out of 3.5 million acres of agricultural land in the counties studied, or less than 10 percent of the total agriculture lands in these counties. The studies did not evaluate the effect of crop idling on commodity markets.

A statewide economic-engineering optimization study by the University of California, Davis (Jenkins, et al. 2001; Newlin et al. 2002) highlights potential benefits of water transfers to meet forecasted future water scarcity. Results suggest that by 2020 water transfers combined with conjunctive management and various operational changes could provide additional economic benefits as high as $1.3 billion per year statewide by reducing forecasted economic impacts of water scarcity as much as 80 percent. Almost all of the benefit comes from regional water transfers and operational improvements within five regions of California, especially in southern California. The study indicates that the maximum reduction in deliveries to a major water user would be 15 percent with most transfers averaging much less. Much of the added benefits would be from increased flexibility added to the water management system through reoperation of surface water and groundwater supplies using conjunctive management. As an optimization study, these results represent a simplification of California's water management system and do not address legal and institutional barriers that may prevent full implementation.

Potential costs

The financial costs of completing a water transfer includes more than just the sale price of water, which is typically at the seller's last point of control of the water. Additional financial costs to the buyer include conveyance, storage, and treatment costs, and physical losses between the location and time of sale and the place and time the water is used by the buyer. Sale prices alone reflect the cost to make the water physically available and, in some cases, added monitoring or mitigation needed to ensure compliance with state legislative guidance related to water transfers. The buyer typically then arranges for the water to be conveyed to their area of use. Conveyance costs can be significant, as much as the price paid to the seller for the water. Prices paid to the seller in 2002 and 2003 for the Environmental Water Account and Dry Year Water Purchase Programs operated by DWR ranged from $75 to $185 per acre-foot. The lower prices reflecting a source in Northern California and the higher prices reflecting the price to EWA of banked groundwater and conveyance costs in Kern County in years of 50 percent State Water Project allocations.

In addition to the direct costs of a water transfer to the receiving areas, indirect costs to third parties also can occur. These economic concerns are discussed in more detail under the issues.

Major issues

Maintaining agricultural productivity - Because most water transfers come from agriculture, it is important to include the protection of agricultural productivity and economic benefits in water transfer policies. A key challenge is to balance the ability of agriculture to provide water for transfers on a periodic basis to help with temporary water supply shortages with limits so that transfers do not destabilize the agriculture infrastructure.

Balanced approach to regulating transfers – State water law requires that transfers not injure any other legal user of water, not unreasonably affect fish and wildlife, and not unreasonably affect the overall economy of the county from which the water is transferred. There is a concern by some that existing state laws are not adequate to protect the environment, third parties, and broader social interests that may be affected by water transfers. This is particularly the concern for water transfers involving pre-1914 water rights, which are not subject to regulation by SWRCB, and transfers that involve pumping groundwater or crop idling and crop shifting. Conversely, there is also concern that efforts to more heavily regulate water transfers may unnecessarily restrict many short term, intra-regional transfers that have multiple benefits during temporary supply shortages and have little likelihood of direct or indirect impacts. The key issue is how to balance these concerns to allow water transfers to continue as a viable water management strategy while having mechanisms in place to minimize effects on others.

Environmental concerns – Environmental consequences of transfers can occur in three places: the area *from* which the water is transferred, the area *through* which the water is transferred and to the area *to* which the water is transferred. Cumulative effects of short- and long- term transfers could have impacts on habitat, water quality, and wildlife caused by substituting groundwater for surface water, changing the location, timing, and quantity of surface diversions, or changing crop patterns through crop shifting or idling. For example, rice growing areas can have significant secondary benefits as wildlife habitat. Transfers that involve crop idling in these areas could have either impacts or benefits to wildlife depending on implementation. Transfers that involve increased groundwater pumping also raises concerns over groundwater overdraft and the long term sustainability of groundwater resources. In addition, long term water transfers that induce new growth in the receiving area may have environmental impacts. Transfers under the Environmental Water Account, Central Valley Project Improvement Act, and related programs are designed to improve environmental conditions. There is a concern that because these transfers are year to year, they may not provide for long term protection of the environment. There is also a concern by those who traditionally relied on return flows from upstream areas as a source of supply that they may be impacted by water transfers or water conservation measures that change the timing and quantity of flows.

Economic concerns – Short term, out of county transfers created through extensive crop idling can reduce production and employment of both on farm and secondary economic sectors resulting in reduced tax revenues and increased costs for farmers not participating in the transfer. These reduced revenues could effect local governments disproportionately with potential impacts to spending on a wide range of services provided by local government. Long-term transfers could result in similar impacts even though the actual amount of fallowed land may be less. Especially in the case of long-term transfers, impacts to other elements of the local community (schools, businesses etc.) may be more widespread and severe. Transfers of surface water that are replaced by increasing groundwater pumping may drop groundwater levels and increase the pumping costs to other groundwater users.

State law generally requires that water transfers not unreasonably affect the overall economy of the county from which the water is transferred (referred to as source areas). However, there is potential for some economic disruption to source areas depending on the source of transferred water, the amount of water transferred, and the duration of the transfer. A review of past water transfers has not shown long-term economic impacts to source areas. However, there is a concern that these areas could experience long-term economic impacts if transfers become more widespread. Water scarcity can also cause economic impacts, both where the shortage occurs and far beyond. Water transfers can help reduce water scarcity in areas receiving transfers thereby helping to avoid job losses and secondary economic impacts in these areas. For this reason, on a statewide basis, economic impacts to source areas are likely offset by economic benefits to areas receiving transferred water.

Quantifying uncertainties and ensuring the transfer of real water – Transfers, especially those where water is moved long distances, are often limited by physical capacity of the conveyance systems, environmental and water quality regulations, losses along the flow path, linkages between surface water and groundwater movement and use, and other factors that are difficult to quantify or anticipate. Quantifying the actual water savings from crop shifting and crop idling is particularly difficult because only the consumptive use by the crop is transferable in most cases. There is always a risk that the best estimates of the water supply benefits from the transfer to the water system (estimates of "real water") will not have unintended consequences to other water users or the environment. A key challenge is to improve methods for quantifying these uncertainties and to include adequate monitoring and assurances when implementing water transfers. Monitoring is particularly critical for transfers that either result in water savings from crop idling or increase groundwater use. Information may be needed on historical and current land use and water use, groundwater levels, land subsidence, water quality, environmental conditions, and surface water flows.

Lack of integrated management of water resources – In California, authority is separated among local, state and federal agencies for managing different aspects of groundwater and surface water resources. Several examples highlight this: 1) SWRCB has jurisdiction for appropriative water rights dating from 1914, but disputes over appropriative water rights dating before 1914 are settled by the court system; 2) Similarly, SWRCB has jurisdiction over groundwater quality, but disputes over groundwater use are settled by the court system ; 3) Ordinances adopted by counties to protect groundwater resources only apply to the portion of the groundwater basin they overlie and may conflict with water districts trying to implement water transfers that have their own groundwater management plan. Failure to integrate water management across jurisdictions makes it difficult to develop transfers with multiple benefits, provide for sustainable use of resources, identify and protect or mitigate potential impacts to third parties, and ensure protection of legal rights of water users, the environment, and public trust resources.

Infrastructure and operational limits – The ability to optimize the benefits of water transfers is highly dependent on access to and the physical capacity of existing conveyance and storage facilities. For example, when export facilities in the Delta are already pumping at full capacity, transferable water cannot be moved. This occurred in 2003 when the Metropolitan Water District of Southern California (MWDSC) negotiated water transfers with growers in the Sacramento Valley but was unable to move water through the Delta where the conveyance system was flowing full, or to store the water in Lake Oroville, which filled with late spring rain. The ability to convey water is also an important aspect of the potential water transfer between Imperial Valley and the San Diego County Water Authority, and would need access to the Colorado River Aqueduct that is owned and operated by MWDSC.

Recommendations

- Local government and water agencies should take the lead role and provide for community participation when addressing conflicts caused by transfers within their jurisdictions. Actions that can demonstrate local leadership can include:
  - developing a groundwater management plan to guide implementation of water transfers that increase groundwater use or that could impact groundwater quality.
  - implementing monitoring programs that evaluate potential project specific and cumulative impacts from transfers, provide assurances that unavoidable impacts are mitigated to a reasonable level, and demonstrate that transfers comply with existing law, which requires that transfers do not injure any other legal user of water, do not unreasonably affect fish and wildlife, and do not unreasonably affect the overall economy of the county from which the water is transferred.
  - evaluating and implementing regional water management strategies to improve regional water supplies to meet municipal, agricultural, and environmental water needs and minimize the need of importing water from other hydrologic regions.
- The state, in addition to implementing state law, should assist with resolving potential conflicts over water transfers when local government and water agencies are unable to do so.
- Actions where state and federal agency assistance on-going and needs to be continued include:
  - preparing programmatic and site specific CEQA/NEPA documents to assess cumulative effects of inter-regional transfers anticipated to occur under the Environmental Water Account and Sacramento Valley Water Management Agreement.
  - improving conditions in the Delta and identifying and reducing statewide conveyance limitations.
  - Streamlining the approval process of state and federal

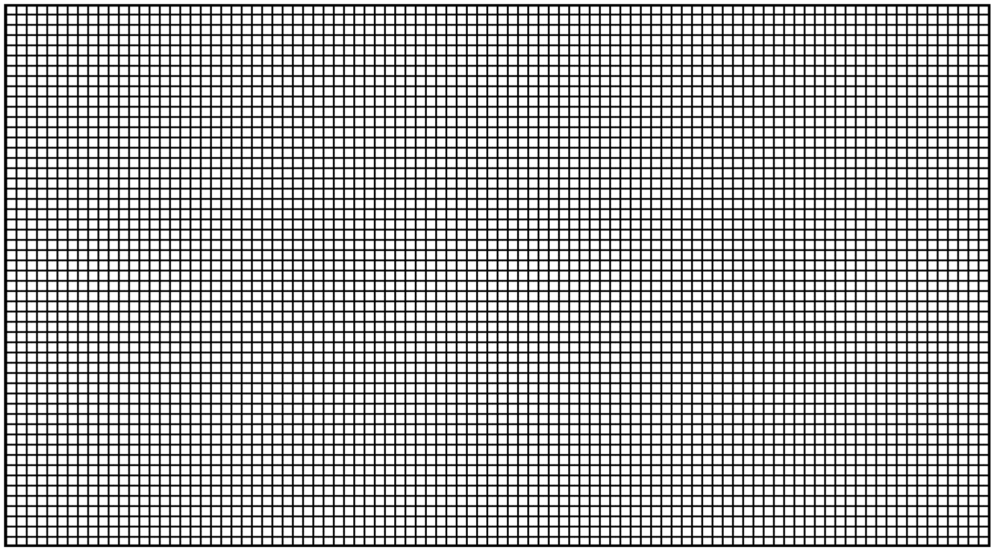
agencies for water transfers while protecting water rights, the environment, and local economic interests.

- working with agencies proposing water transfers that move water through the Delta to monitor and evaluate effects that could impact the condition of the San Francisco Bay-Delta ecosystem, either singly or in a cumulative manner.
- refining current methods with interested parties on how to identify and quantify water savings for transfers using crop idling and shifting
- developing, with interested parties, acceptable ways to identify, lessen, and distribute economic impacts from transfers that use crop idling and shifting.
- funding local and regional groundwater management activities that promote sustainable and coordinated use of surface water groundwater.
- Continuing efforts to seek consensus among interested parties about the role of water transfers as a water management strategy while identifying and protecting or mitigating potential impacts to other water users, third parties, the environment, and public trust resources.

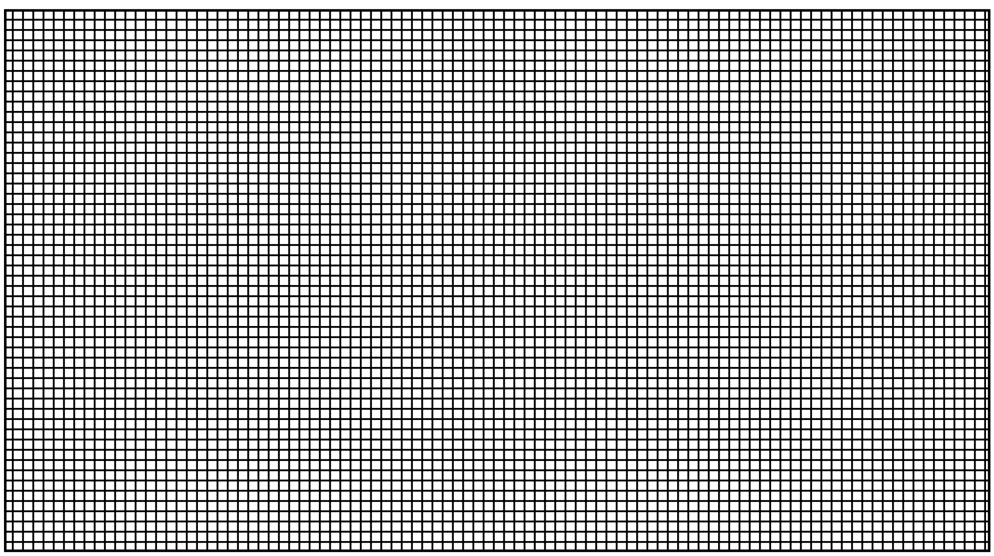
■ Actions the state can implement to improve management of water transfers include:

- improving coordination and cooperation among local, state, and federal agencies with differing responsibilities for surface water and groundwater management in order to facilitate sustainable transfers with multiple benefits, to allow efficient use of agency resources, and to promote easy access to information by the public.
- developing water transfer policies that balance the ability of agriculture to provide water for transfers on a periodic basis to help with temporary water supply shortages with limits so that transfers do not destabilize the agriculture infrastructure.
- encouraging agencies proposing water transfers to coordinate with wildlife and water quality agencies to obtain multiple benefits from proposals. For example, transfers intended for urban or agricultural use may also be scheduled to enhance flows for aquatic species in areas between the seller and buyer.
- implementing water transfers, when serving as a purchaser,

in cooperation with local partners, consistent with state water and environmental laws, and at a fair price.



Placeholder for graph: Water transfers by type of end user



Placeholder for graph: Temporary water tranfers in California since 1985

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Working lands management

In Progress

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Other research and development

In Progress

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